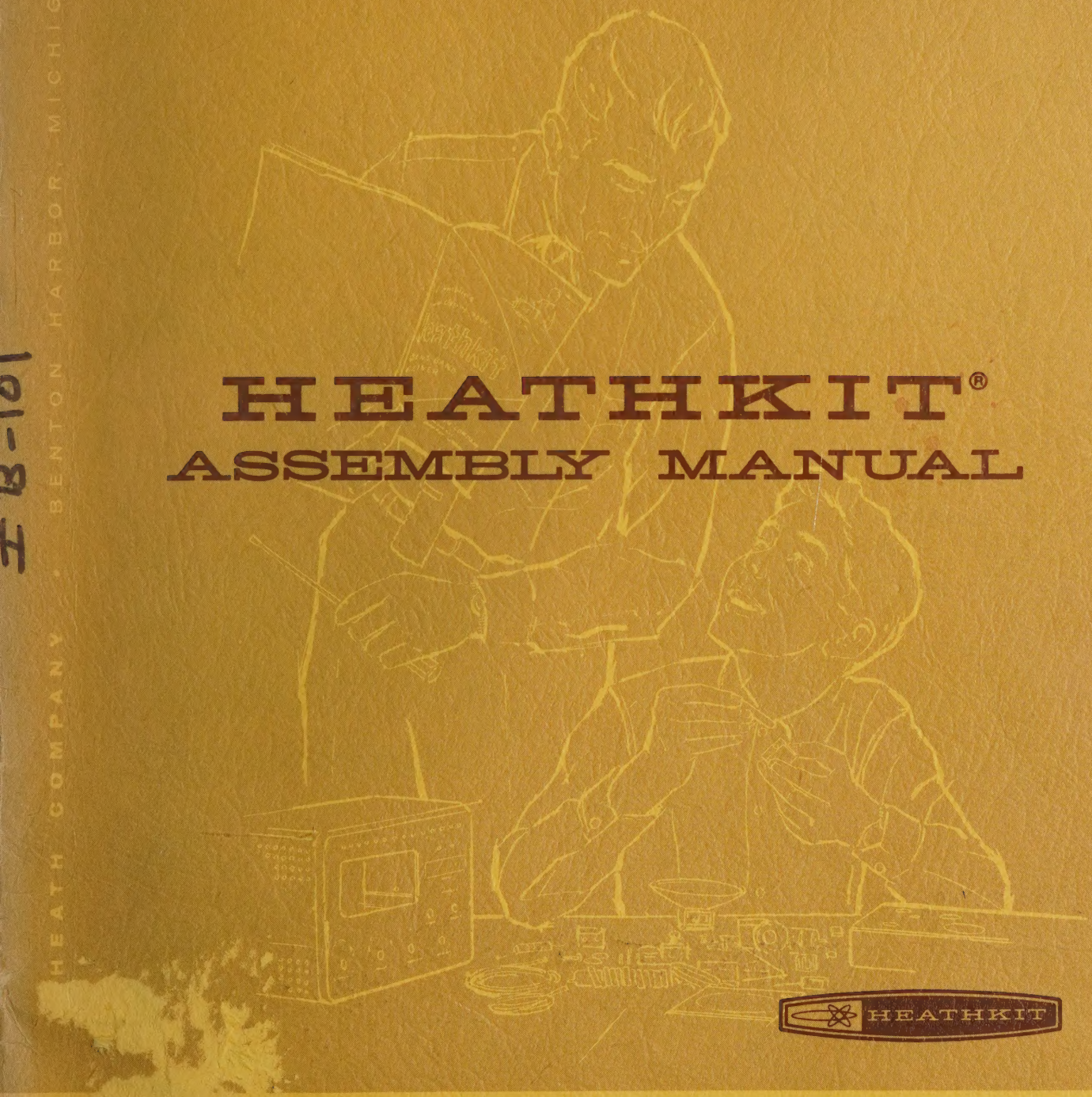
PRICE $2.00

HEATH COMPANY • BENTON HARBOR, MICHIGAN

IB-101

HEATHKIT®
ASSEMBLY MANUAL



HEATHKIT

FREQUENCY COUNTER

file – MODEL IB-101

CI-496 CERT. LAB

595-1278-02

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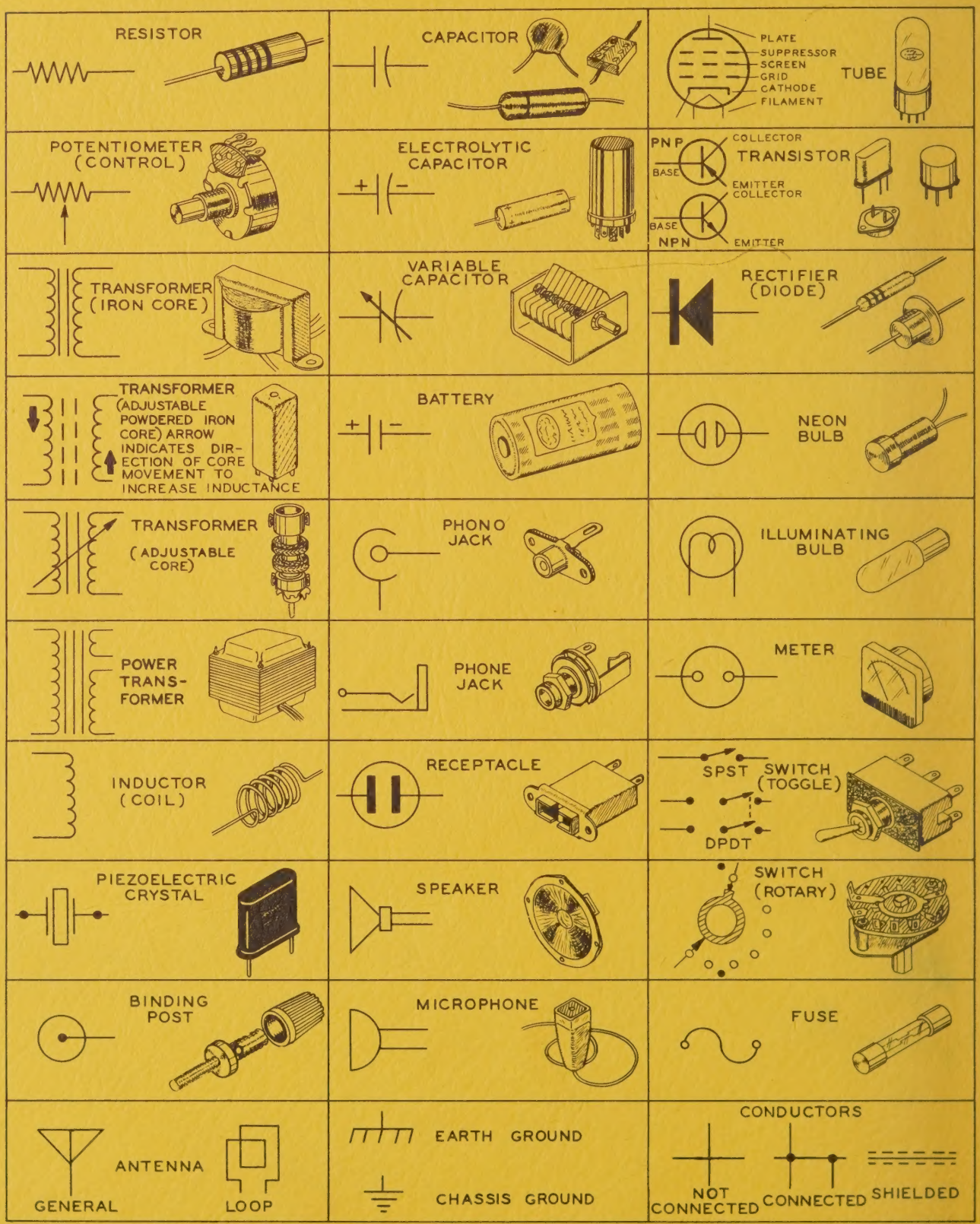
TYPICAL COMPONENT TYPES

This chart is a guide to commonly used types of electronic components. The symbols and related illustrations should prove helpful in identifying most parts and reading the schematic diagrams.



Assembly and Operation of the HEATHKIT®

FREQUENCY COUNTER

MODEL IB-101

TABLE OF CONTENTS

INTRODUCTION	2
PARTS LIST	2
ASSEMBLY NOTES	4
STEP-BY-STEP ASSEMBLY	5
Circuit Board	5
Chassis Parts Mounting	18
Alternate Line Voltage Wiring	21
Front Panel Assembly	22
Front Panel Mounting	24
Final Wiring	25
Test Cable Assembly	26
INITIAL CHECKOUT	28
FINAL ASSEMBLY	29
CALIBRATION	32
Without Instruments	32
With Instruments	34
OPERATION	36
IN CASE OF DIFFICULTY	37
Troubleshooting Chart	38
FACTORY REPAIR SERVICE	39
SPECIFICATIONS	40
CIRCUIT DESCRIPTION	42
CHASSIS PHOTOGRAPHS	48
CIRCUIT BOARD X-RAY VIEW	50
CIRCUIT BOARD VOLTAGE CHARTS	51
REPLACEMENT PARTS PRICE LIST	52
IDENTIFICATION CHART	54
SCHEMATIC. . .(fold-out from page)	55

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

INTRODUCTION

The Model IB-101 Heathkit Frequency Counter is a compact, lightweight, and rugged digital frequency counter. The basic functions and uses of this Instrument are like those found in other high quality frequency counters.

Many features make the Counter convenient and easy to operate. Five cold-cathode display tubes, an overrange lamp, and two range indicator lamps provide an easy-to-read "readout." The "readout" accuracy is assured by the modern digital techniques and a crystal-controlled "clock."

A high impedance (MOSFET) input circuit presents minimum loading to the circuit under test, and the automatic level triggering feature provides simple "hands-off" operation. The Counter's two regulated power supplies can be operated from either a 105 to 125 or a 210 to 250 volt 50/60 Hz ac power source.

Lightweight and reliable plug-in integrated circuits minimize and simplify maintenance. The detachable test cable and line cord and the three-detent position bail-handle make the Counter completely portable. The unique bail-handle can be used to position the Counter at a desirable viewing angle.

PARTS LIST

Check each part against the following parts list. The key numbers correspond to the numbers on the Parts Pictorial (fold-out from Page 7).

To order replacement parts, refer to the "Replacement Parts Price List" and use the Parts Order Form furnished with this kit.

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION
RESISTORS			
1/2-Watt, 5%			
1	1-151	1	330 Ω (orange-orange-brown)
	1-157	2	470 Ω (yellow-violet-brown)
	1-52	1	680 Ω (blue-gray-brown)
	1-81	1	1500 Ω (brown-green-red)
	1-150	2	3000 Ω (orange-black-red)
	1-122	1	3300 Ω (orange-orange-red)
	1-43	1	4700 Ω (yellow-violet-red)
	1-51	1	6800 Ω (blue-gray-red)
	1-105	8	10 kΩ (brown-black-orange)
	1-115	3	47 kΩ (yellow-violet-orange)
	1-50	1	68 kΩ (blue-gray-orange)
	1-104	1	100 kΩ (brown-black-yellow)
	1-101	2	1MΩ (brown-black-green)
Other Resistors-Control			
	1-9	3	1000 Ω, 1/2-watt, 10% (brown-black-red) resistor
2	2-219	1	21.62 Ω, 1% resistor
3	3-2-5	1	10 kΩ, 5-watt resistor
4	10-171	2	500 Ω control

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION
CAPACITORS			
Disc			
5	21-24	1	800 pF
	21-52	1	.002 μF
	21-47	1	.01 μF
	21-48	4	.05 μF
Mica			
6	20-101	1	47 pF
	20-102	3	100 pF
	20-107	1	680 pF
Electrolytic			
7	25-94	1	10 μF
8	25-128	1	100 μF
	25-201	2	2000 μF
Other Capacitors			
9	31-36	1	8-50 pF trimmer
10	21-41	1	14 pF ceramic (violet-brown-yellow-black-green)

TUBE-TRANSISTORS-INTEGRATED CIRCUITS

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION
11	411-264	5	B5859S display tube

NOTE: Transistors and integrated circuits are marked for identification in one of the following four ways:

1. Part number.
2. Transistor or integrated circuit type number.
3. Part number and type number.
4. Part number with a type other than the one listed.

12	417-118	2	2N3393 transistor
	417-201	3	X29A829 transistor
13	417-173	1	NPN transistor
14	417-240	1	40673 transistor
15	417-175	1	TA2911 transistor
16	443-8	1	MC724P integrated circuit
	443-14	1	MC789P (selected) integrated circuit
	443-28	10	CμL995879 integrated circuit
	443-29	5	CμL995979 integrated circuit
	443-30	5	CμL996079 integrated circuit
	443-31	1	MC726P (selected) integrated circuit
	443-32	3	MC790P (selected) integrated circuit

DIODES-CRYSTAL-LAMP

17	56-26	1	Crystal diode, 1N191 (brown-white-brown)
	56-55	1	36 V zener diode, VR-36A
	56-59	1	4.7 V zener diode, 1N750A (violet-green-brown)
	57-27	3	Silicon diode, 1N2071
18	404-414	1	1 MHz crystal
19	412-49	3	Neon lamp

SWITCHES-SOCKETS-ADAPTER-CONNECTORS

20	60-40	1	3PDT switch
21	60-45	1	SPST switch
22	432-76	1	AC power socket
23	434-201	5	Tube socket
24	432-27	1	Plug adapter
25	432-59	1	BNC connector (with hardware)
26	432-144	393	Integrated circuit (IC) connector

LINE CORD-WIRE-CABLE

89-30	1	3-wire line cord
340-11	1	Bare wire
344-50	1	Black wire
344-51	1	Brown wire
344-21	1	Large red wire
344-52	1	Small red wire
344-53	1	Orange wire
344-54	1	Yellow wire
344-55	1	Green wire
344-56	1	Blue wire
344-57	1	Violet wire
344-58	1	Gray wire
134-237	1	Cable assembly (with connector)

HARDWARE

#4 Hardware

27	250-3	4	4-40 x 3/16" screw
28	250-52	11	4-40 x 1/4" screw
29	252-15	7	4-40 nut
30	254-9	7	#4 lockwasher

#6 Hardware

31	250-89	10	6-32 x 3/8" screw
32	250-434	8	6-32 x 3/8" flat head screw
33	250-535	2	6-32 x 1/4" screw
34	252-3	14	6-32 nut
35	254-1	16	#6 lockwasher
36	259-1	1	#6 solder lug
37	255-103	1	6-32 x 5/16" threaded spacer

Other Hardware

38	253-75	3	3/8" flat washer

METAL PARTS

39	90-505-1	2	Cabinet shell
40	200-592	1	Chassis
41	100-1039	1	Front panel
42	203-747-1	1	Rear panel
43	203-748	1	Left panel
44	203-749	1	Right panel
45	205-780	2	Cabinet trim plate
46	211-51	1	Handle
47	258-106	1	Flat spring
48	266-194	1	Handle detent
49	205-141	2	Tool plate

MISCELLANEOUS

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION
50	40-581	2	620 μH coil
	54-260	1	Power transformer
51	73-34	2	Rubber insulator
	85-422-2	1	Circuit board
52	205-778	1	1/8" x 1" metal strip
53	211-52	1	Plastic handle-grip
54	214-124	2	Lamp housing
55	260-16	2	Alligator clip
56	261-29	4	Plastic foot
57	262-13	1	Pin
58	390-331	1	Control label

Miscellaneous (cont'd.)

KEY No.	PART No.	PARTS Per Kit	DESCRIPTION
59	75-156	1	Light shield
60	390-357	1	"Heathkit" label
	421-33	1	1/4-ampere, slow-blow fuse
61	422-1	1	Fuseholder
62	431-38	2	3-lug terminal strip
63	490-5	1	Nut starter
	391-34	1	Blue and white label
	597-308	1	Kit Builders Guide
	597-260	1	Parts Order Form
		1	Manual (See front cover for part number.)
			Solder

ASSEMBLY NOTES

Before starting to assemble this kit, be sure you have read the wiring, soldering, and step-by-step assembly information in the "Kit Builders Guide."

Due to the small foil area around the circuit board holes and the small areas between foils, it will be necessary to use the utmost care to prevent solder bridges between adjacent foil areas. Use only a minimum amount of solder, and do not heat components excessively with the soldering iron. Diodes, transistors, etc., can be damaged if subjected to excessive amounts of heat. Use no larger than a 25-watt soldering iron with a small tip. Allow it to reach operating temperature, and then apply it only long enough to make a good solder connection.

NOTE: If a small wattage, small-tip soldering iron is not available, proceed as follows: Be sure your soldering iron is cool. Then wrap the large bare wire, supplied with this kit, tightly around the soldering iron tip as shown in Figure 1. Allow approximately 1/2" of wire to extend beyond the end of the soldering iron. Cut the wire end to a chisel shape as shown.

Resistors will be called out by their resistance value in Ω, kΩ, or MΩ, and color code. Use 1/2-watt resistors unless directed otherwise.

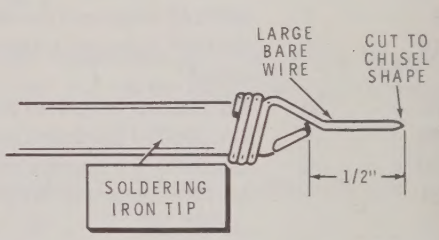


Figure 1

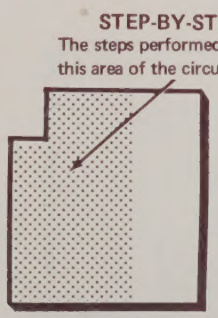
Capacitors will be called out by their capacitance value (in pF or μF) and type (disc, mica, or electrolytic).

NOTE: The circuit board has foil on both sides of the board. Components will be installed on the screened (side with the component outlines) side, and the leads will be soldered to the foil on the other side. Never make a solder connection on the screened side of the circuit board. Due to the nature of the board, solder may be drawn through a circuit board hole to the screened side. This is normal.

STEP-BY-STEP ASSEMBLY

CIRCUIT BOARD

Components will be installed on the circuit board by following the steps on Pictorials 1 through 13. Position all parts as they are shown.


STEP-BY-STEP ASSEMBLY
The steps performed in this Pictorial are in this area of the circuit board.
IDENTIFICATION DRAWING

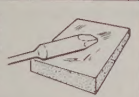
START

NOTE: Be sure you have read the Assembly Notes (on the preceding page) before performing the following steps.

Position the circuit board as shown in the identification drawing. Then complete each step on the Pictorial.

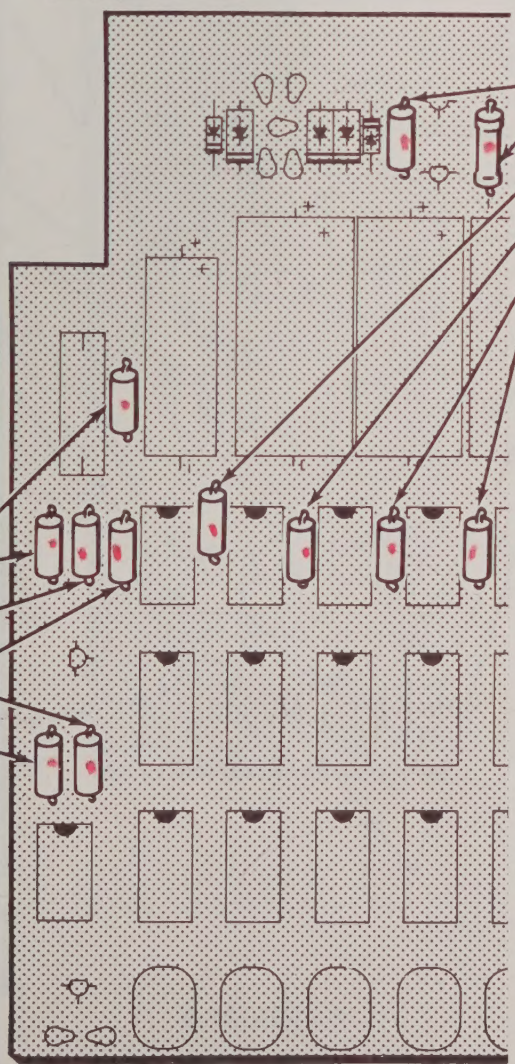
- ( ) 47 kΩ (yellow-violet-orange).
- ( ) 1000 Ω (brown-black-red).
- ( ) 47 kΩ (yellow-violet-orange).
- ( ) 10 kΩ (brown-black-orange).
- ( ) 1000 Ω (brown-black-red).
- ( ) 1000 Ω (brown-black-red).

FOR GOOD SOLDERED CONNECTIONS, YOU MUST KEEP THE SOLDERING IRON TIP CLEAN... WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH.



- ( ) Turn the circuit board over and solder the leads to the foil. Cut off the excess lead lengths.

NOTE: Never make a solder connection to the screened (component) side of the circuit board.

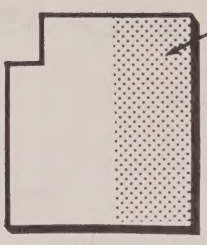


CONTINUE

- ( ) 1500 Ω (brown-green-red).
- ( ) 21.62 Ω, 1%.
- ( ) 10 kΩ (brown-black-orange).
- ( ) 10 kΩ (brown-black-orange).
- ( ) 10 kΩ (brown-black-orange).
- ( ) 10 kΩ (brown-black-orange).
- ( ) Turn the circuit board over and solder the leads to the foil. Cut off the excess lead lengths.

PROCEED TO PICTORIAL 2.

PICTORIAL 1



The steps performed in this Pictorial are in this area of the circuit board.

IDENTIFICATION DRAWING

START

( ) 68 kΩ (blue-gray-orange).

( ) 10 kΩ (brown-black-orange).

( ) 3000 Ω (orange-black-red).

( ) 3000 Ω (orange-black-red).

( ) 470 Ω (yellow-violet-brown).

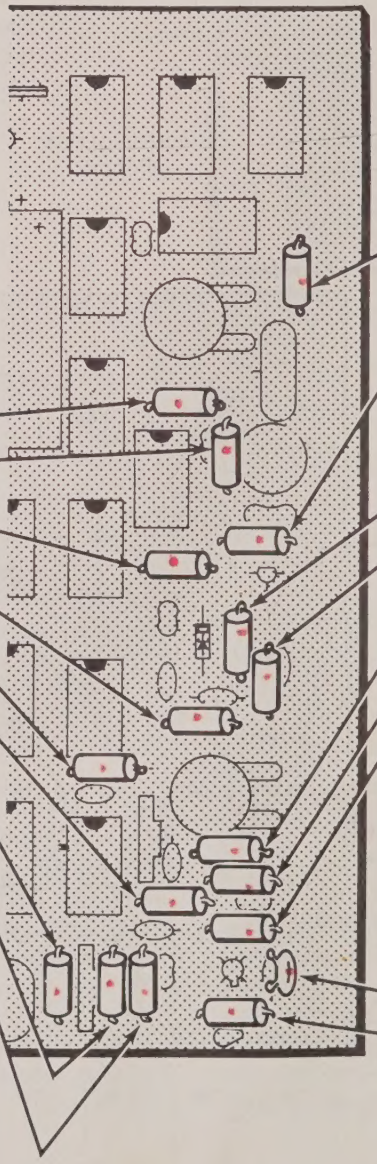
( ) 1 MΩ (brown-black-green).

( ) 47 kΩ (yellow-violet-orange).

( ) 6800 Ω (blue-gray-red).

( ) 330 Ω (orange-orange-brown).

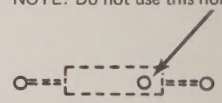
( ) Turn the circuit board over and solder the leads to the foil. Cut off the excess lead lengths.



CONTINUE

( ) 10 kΩ (brown-black-orange).

( ) 470 Ω (yellow-violet-brown).
NOTE: Do not use this hole.



( ) 4700 Ω (yellow-violet-red).

( ) 680 Ω (blue-gray-brown).

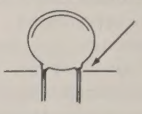
( ) 10 kΩ (brown-black-orange).

( ) 1 MΩ (brown-black-green).

( ) 100 kΩ (brown-black-yellow).

NOTE: When installing disc capacitors, remove any excess coating from the leads. Use long-nose pliers to remove this coating.

REMOVE COATING EVEN WITH BOTTOM OF CAPACITOR BODY.



( ) .05 μF disc.

( ) 3300 Ω (orange-orange-red).

FOR GOOD SOLDERED CONNECTIONS, YOU MUST KEEP THE SOLDERING IRON TIP CLEAN... WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH.

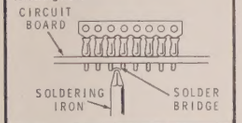
( ) Turn the circuit board over and solder the leads to the foil. Cut off the excess lead lengths.

PICTORIAL 2

PROCEED TO PICTORIAL 3.

START

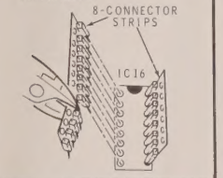
NOTE: In the following steps, you will be instructed to cut off and install strips of IC connectors. Turn the circuit board over and solder each strip of connectors to the foil as it is installed. Be sure each strip is perpendicular to the board before soldering. If a solder bridge occurs, clean the soldering iron tip and hold it between the two points that are bridged, until the excess solder flows down the tip of the soldering iron.



The steps performed in this Pictorial are in this area of the circuit board.

IDENTIFICATION DRAWING

(*) Two strips of eight connectors at IC16 as shown.



(*) Two strips of eight connectors at IC11.

(*) Two strips of eight connectors at IC10.

(*) Two strips of eight connectors at IC9.

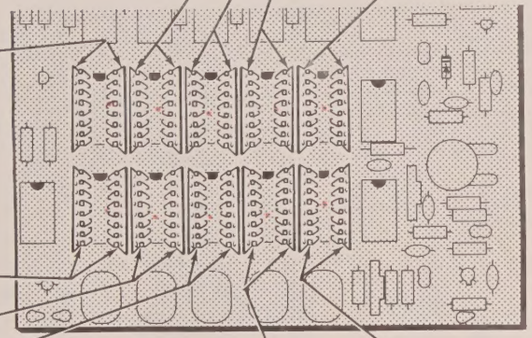
CONTINUE

(*) Two strips of eight connectors at IC15.

(*) Two strips of eight connectors at IC14.

(*) Two strips of eight connectors at IC13.

(*) Two strips of eight connectors at IC12.



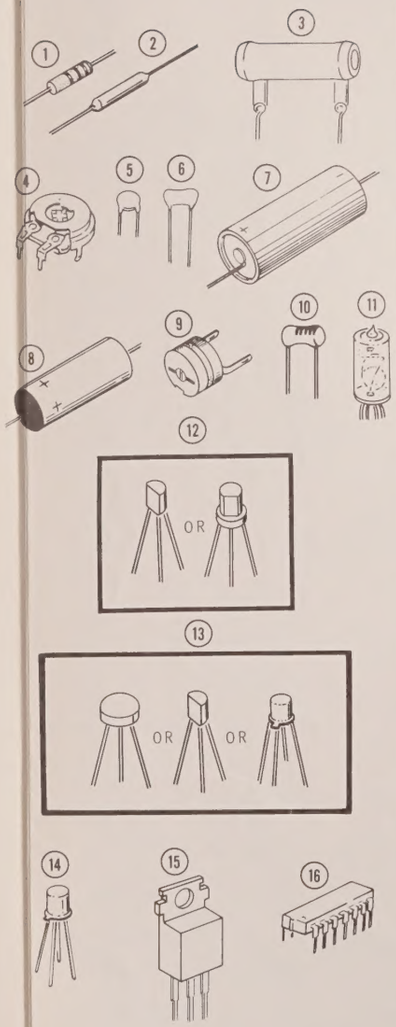
(*) Two strips of eight connectors at IC7.

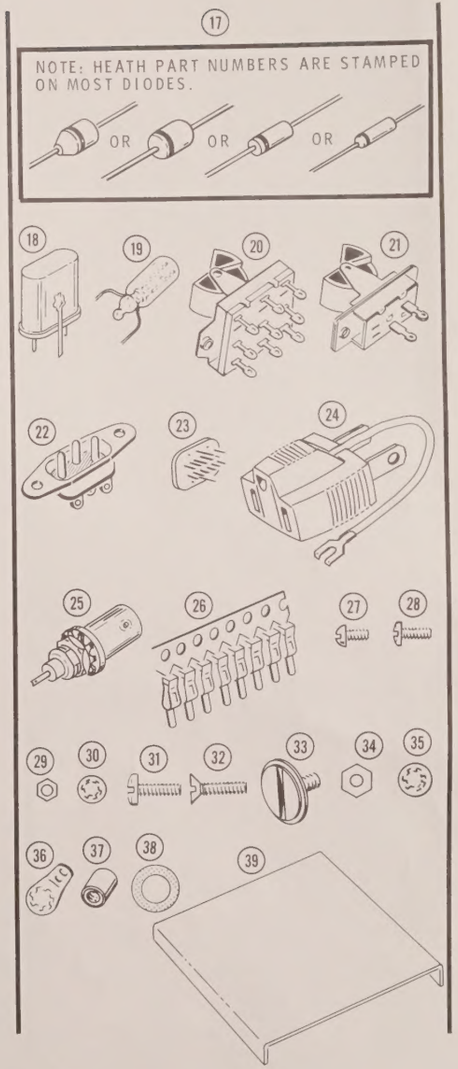
(*) Two strips of eight connectors at IC8.

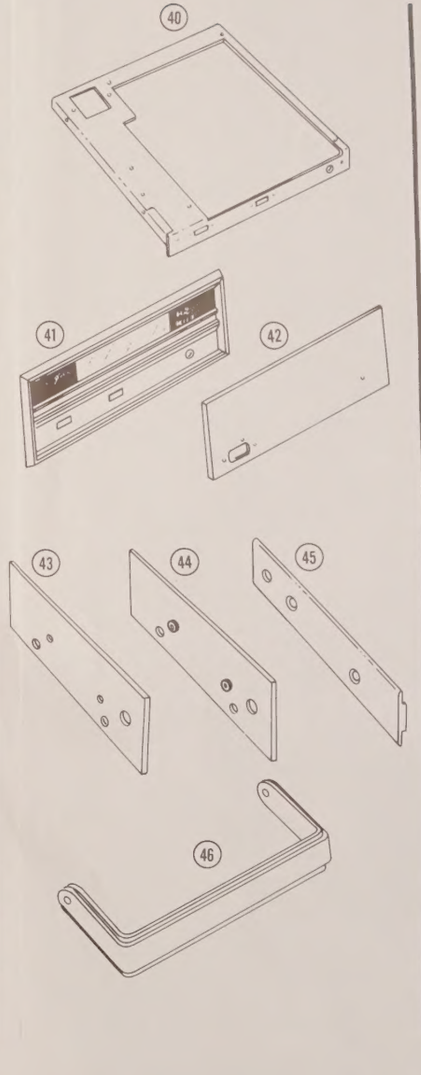
PROCEED TO PICTORIAL 4.

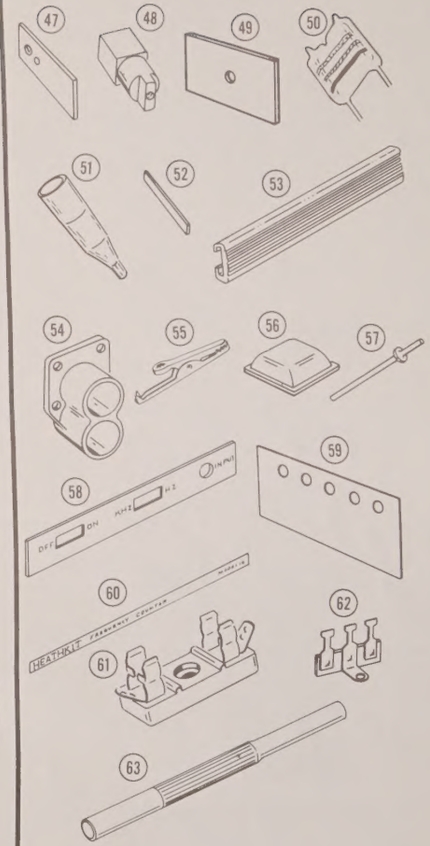
PICTORIAL 3

PARTS PICTORIAL









START

NOTE: The remaining connector strips will each contain seven (7) connectors. Solder the strips to the foil as they are installed.

( ) Two strips of seven connectors at IC3.

( ) Two strips of seven connectors at IC23.

( ) Two strips of seven connectors at IC17.

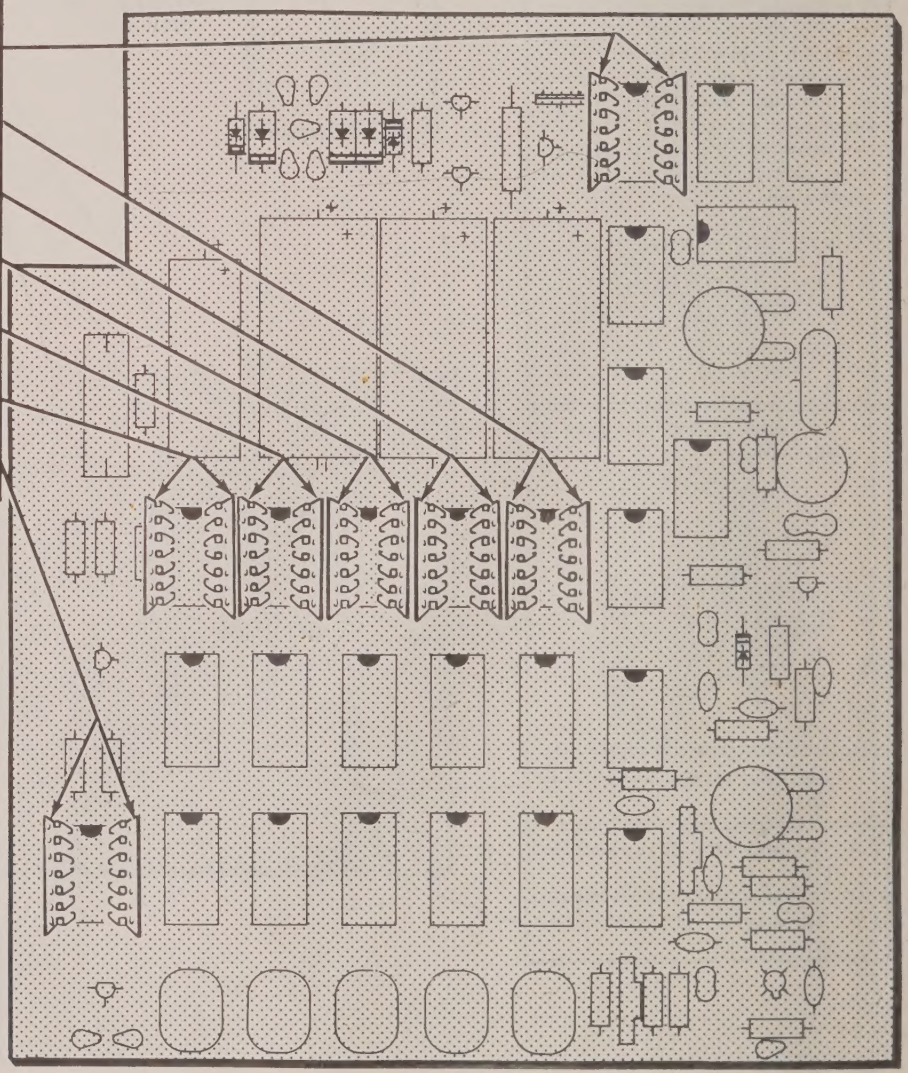
( ) Two strips of seven connectors at IC18.

( ) Two strips of seven connectors at IC19.

( ) Two strips of seven connectors at IC20.

( ) Two strips of seven connectors at IC26.

PROCEED TO PICTORIAL 5.



PICTORIAL 4

START

( ) Two strips of seven connectors at IC4.

( ) Two strips of seven connectors at IC5.

( ) Two strips of seven connectors at IC6.

( ) Two strips of seven connectors at IC2.

( ) Two strips of seven connectors at IC1.

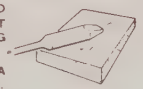
( ) Two strips of seven connectors at IC25.

( ) Two strips of seven connectors at IC22.

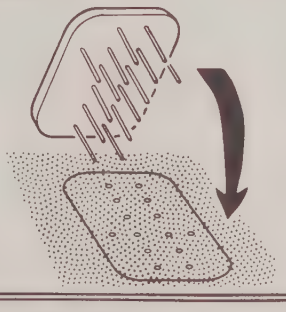
( ) Two strips of seven connectors at IC21.

( ) Two strips of seven connectors at IC24.

FOR GOOD SOLDERED CONNECTIONS, YOU MUST KEEP THE SOLDERING IRON TIP CLEAN... WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH.



When installing the tube sockets in the following steps, turn the circuit board over and solder each socket to the foil as it is installed.



( ) Tube socket at V1.

( ) Tube socket at V2.

( ) Tube socket at V3.

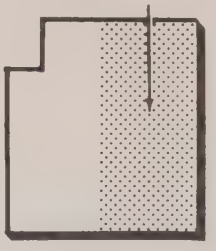
( ) Tube socket at V4.

( ) Tube socket at V5.

PROCEED TO PICTORIAL 6.

PICTORIAL 5

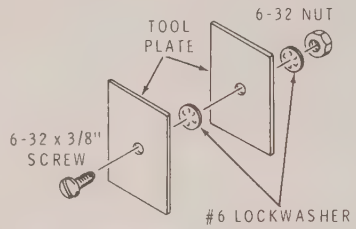
The steps performed in this Pictorial are in this area of the circuit board.



IDENTIFICATION DRAWING

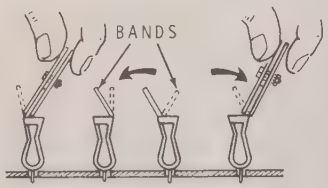
START

( ) Assemble the two tool plates together as shown. Use a 6-32 x 3/8" screw, two #6 lockwashers, and a 6-32 nut.

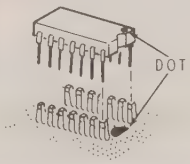


NOTES:

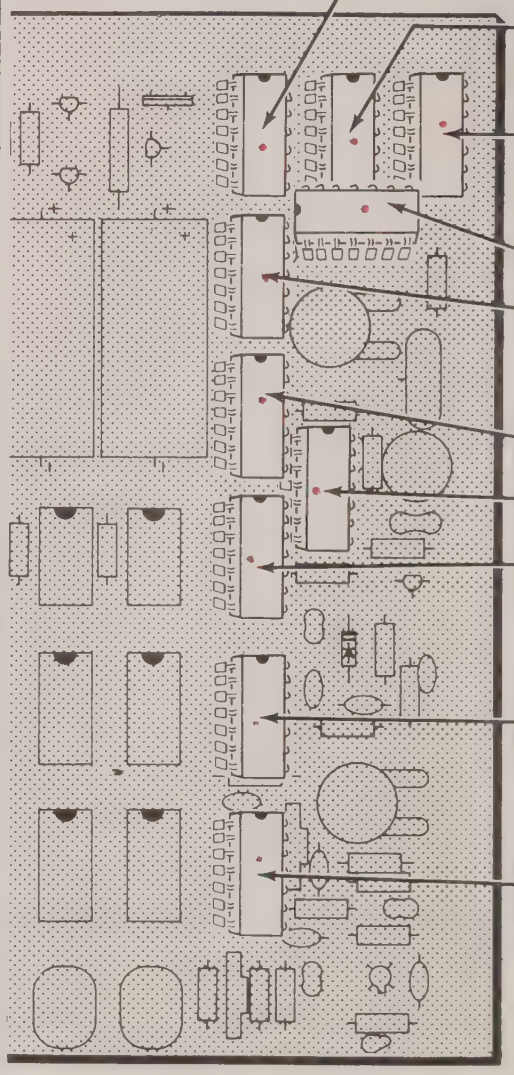
1. When installing an integrated circuit (IC) as in the following steps, use the tool just assembled and remove the bands that join the two rows of IC connector strips. Do this by first bending the band "inward," then bend it "outward" as shown.



2. Position the notch or dot end of the IC over the dot screened on the circuit board. Then insert the IC leads into the IC connectors. DO NOT solder the IC to the connectors.



3. Should it ever become necessary to remove an IC from its connectors, slide a screwdriver blade under the IC; then gently lift the IC out of the connectors.



CONTINUE

( ) Integrated circuit CμL995879 (#443-28) at IC3.

( ) Integrated circuit CμL995879 (#443-28) at IC4.

( ) Integrated circuit CμL995879 (#443-28) at IC5.

( ) Integrated circuit CμL995879 (#443-28) at IC6.

( ) Integrated circuit CμL995879 (#443-28) at IC2.

( ) Integrated circuit CμL995879 (#443-28) at IC1.

( ) Integrated circuit MC724P (#443-8) at IC25.

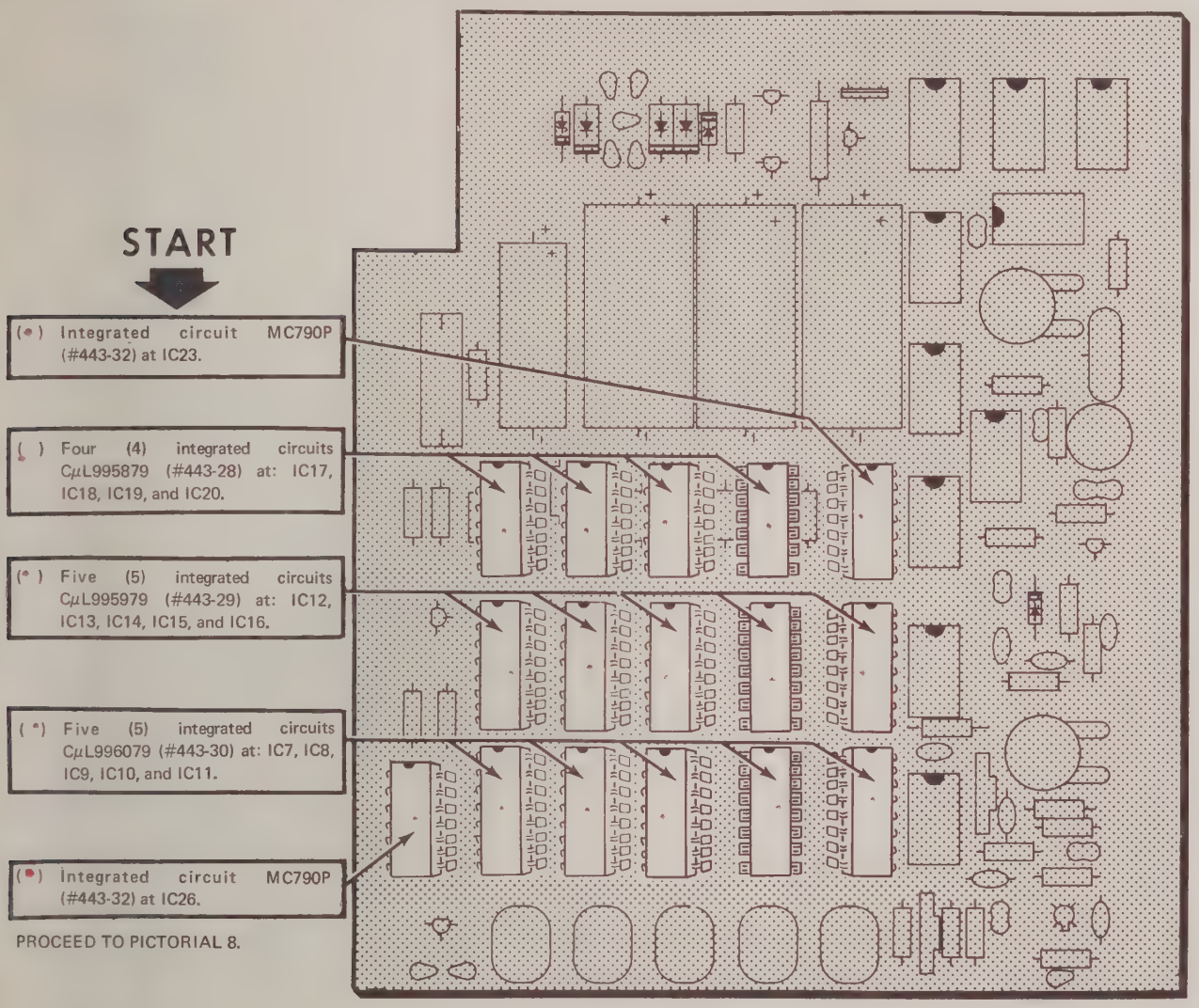
( ) Integrated circuit MC790P (#443-32) at IC22.

( ) Integrated circuit MC726P (#443-31) at IC21.

( ) Integrated circuit MC789P (#443-14) at IC24.

PROCEED TO PICTORIAL 7.

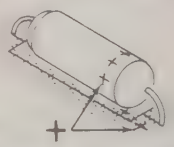
PICTORIAL 6


START
(•) Integrated circuit MC790P (#443-32) at IC23.
( ) Four (4) integrated circuits CμL995879 (#443-28) at: IC17, IC18, IC19, and IC20.
(•) Five (5) integrated circuits CμL995979 (#443-29) at: IC12, IC13, IC14, IC15, and IC16.
(•) Five (5) integrated circuits CμL996079 (#443-30) at: IC7, IC8, IC9, IC10, and IC11.
(•) Integrated circuit MC790P (#443-32) at IC26.
PROCEED TO PICTORIAL 8.

PICTORIAL 7

START

NOTE: When installing the following four electrolytic capacitors, match the positive (+) mark on the capacitor with the positive (+) mark on the circuit board.



( ) 100 µF electrolytic.

( ) 10 µF electrolytic.

( ) 2000 µF electrolytic.

( ) 2000 µF electrolytic.

( ) Turn the circuit board over and solder the leads to the foil. Cut off the excess lead lengths.

( ) 100 pF mica.

( ) 47 pF mica.

( ) 14 pF ceramic (violet-brown-yellow-black-green).

( ) 680 pF mica.

( ) .01 µF disc.

( ) .05 µF disc.

( ) .002 µF disc.

( ) 800 pF disc.

( ) .05 µF disc.

( ) 100 pF mica.

( ) .05 µF disc.

( ) 100 pF mica.

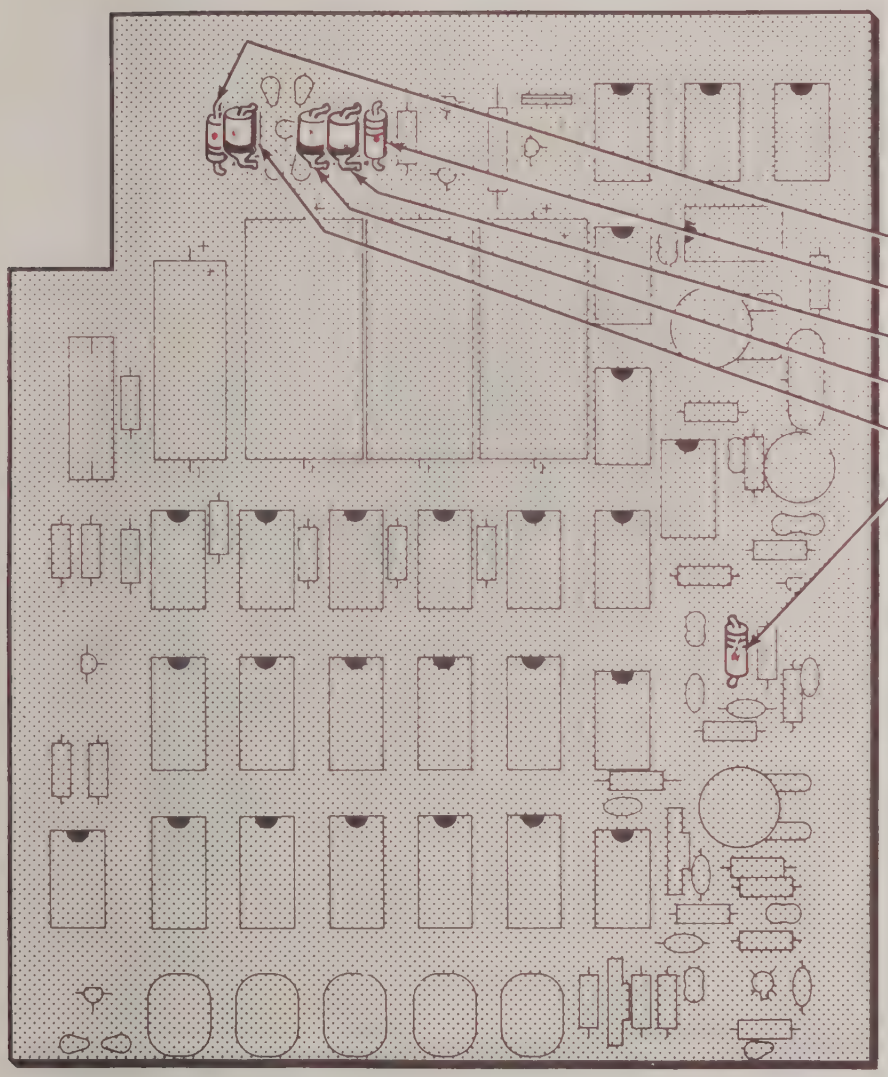
( ) 10 kΩ, 5-watt.

( ) Turn the circuit board over and solder the leads to the foil. Cut off the excess lead lengths.

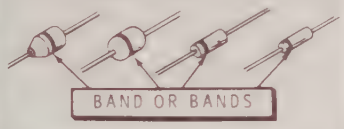
PROCEED TO PICTORIAL 9.

PICTORIAL 8

START



NOTE: DIODES MAY BE SUPPLIED IN ANY OF THE FOLLOWING SHAPES THE CATHODE END OF THE DIODE IS MARKED WITH A BAND OR BANDS. ALWAYS POSITION THIS END AS SHOWN IN THE PICTORIAL.



( ) Zener diode (#56-55) at ZD1.

( ) Zener diode (#56-59) at ZD2.

( ) Silicon diode (#57-27) at D1.

( ) Silicon diode (#57-27) at D2.

( ) Silicon diode (#57-27) at D3.

( ) Crystal diode, (brown-white-brown, #56-26) at D4.

FOR GOOD SOLDERED CONNECTIONS YOU MUST KEEP THE SOLDERING IRON TIP CLEAN

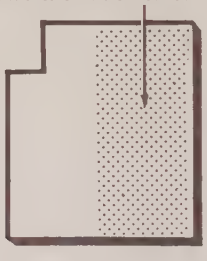
WIPE IT OFTEN WITH A DAMP SPONGE OR CLOTH

( ) Turn the circuit board over and solder the leads to the foil. Cut off the excess lead lengths.

PROCEED TO PICTORIAL 10.

PICTORIAL 9

The steps performed in this Pictorial are in this area of the circuit board.



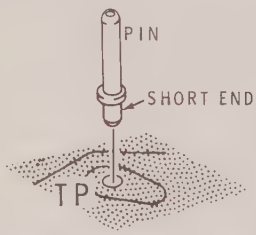
IDENTIFICATION DRAWING

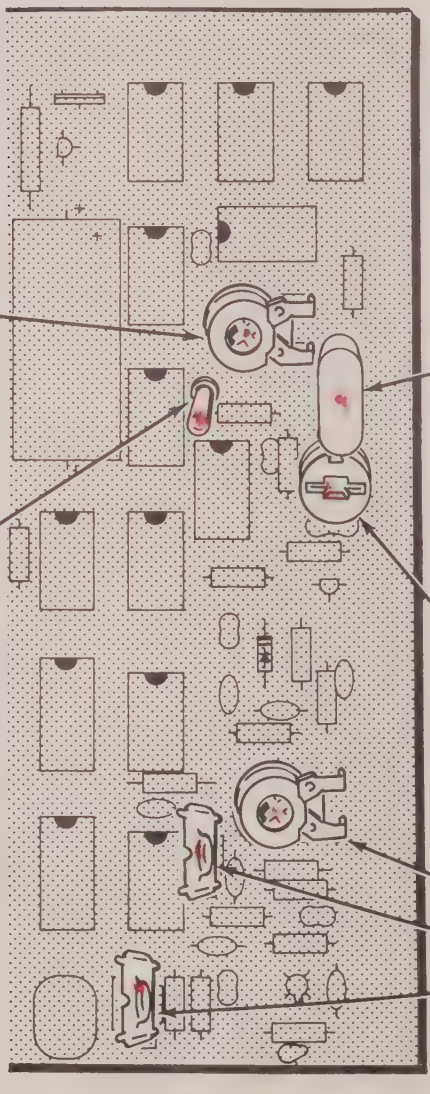
START

NOTE: As each of the following components is installed, turn the circuit board over and solder the component leads to the foil.

( ) 500 Ω control (#10-171).

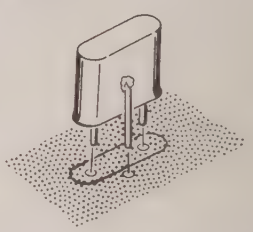
( ) Pin at T.P.





CONTINUE

( ) Crystal.



( ) 8-50 pF trimmer.

( ) 500 Ω control (#10-171).

( ) 620 µH coil.

( ) 620 µH coil.

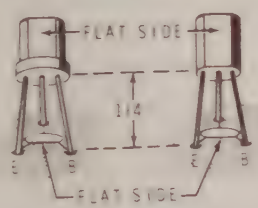
( ) Make sure all connections are soldered, and cut off any excess leads.

PROCEED TO PICTORIAL 11.

PICTORIAL 10

START

NOTE: When installing transistors, place the E, C, and B leads of the transistor in the corresponding E, C, and B holes of the circuit board. Position the transistor 1/4" above the circuit board. Solder all three connections of each transistor as it is installed. Cut off the excess lead lengths.



( ) Transistor 2N3393 (=417-118) at Q7.

( ) Transistor X29A829 (=417-201) at Q6.

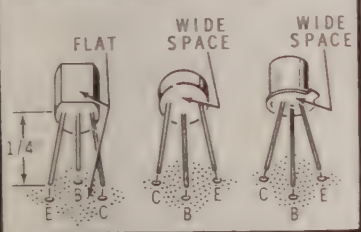
( ) Transistor X29A829 (#417-201) at Q5.

( ) Transistor X29A829 (#417-201) at Q2.

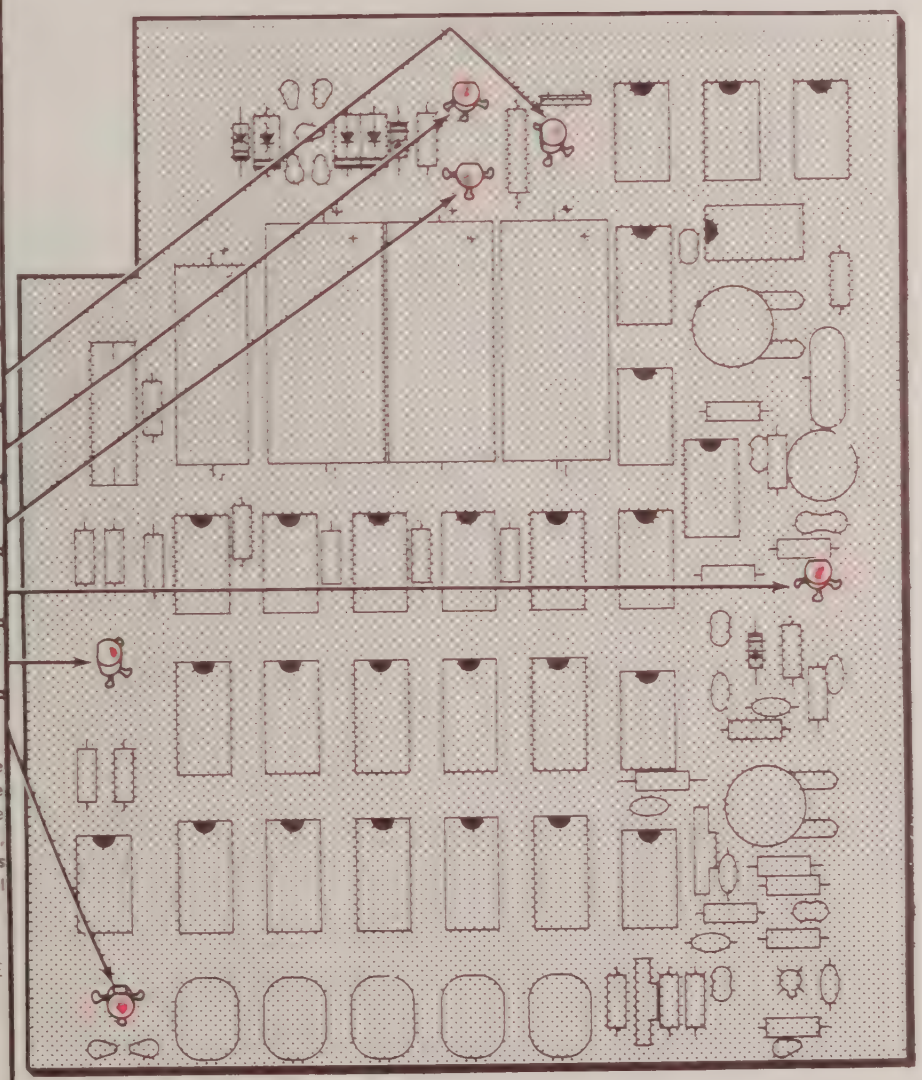
( ) Transistor 2N3393 (#417-118) at Q3.

( ) Transistor (#417-173) at Q4.

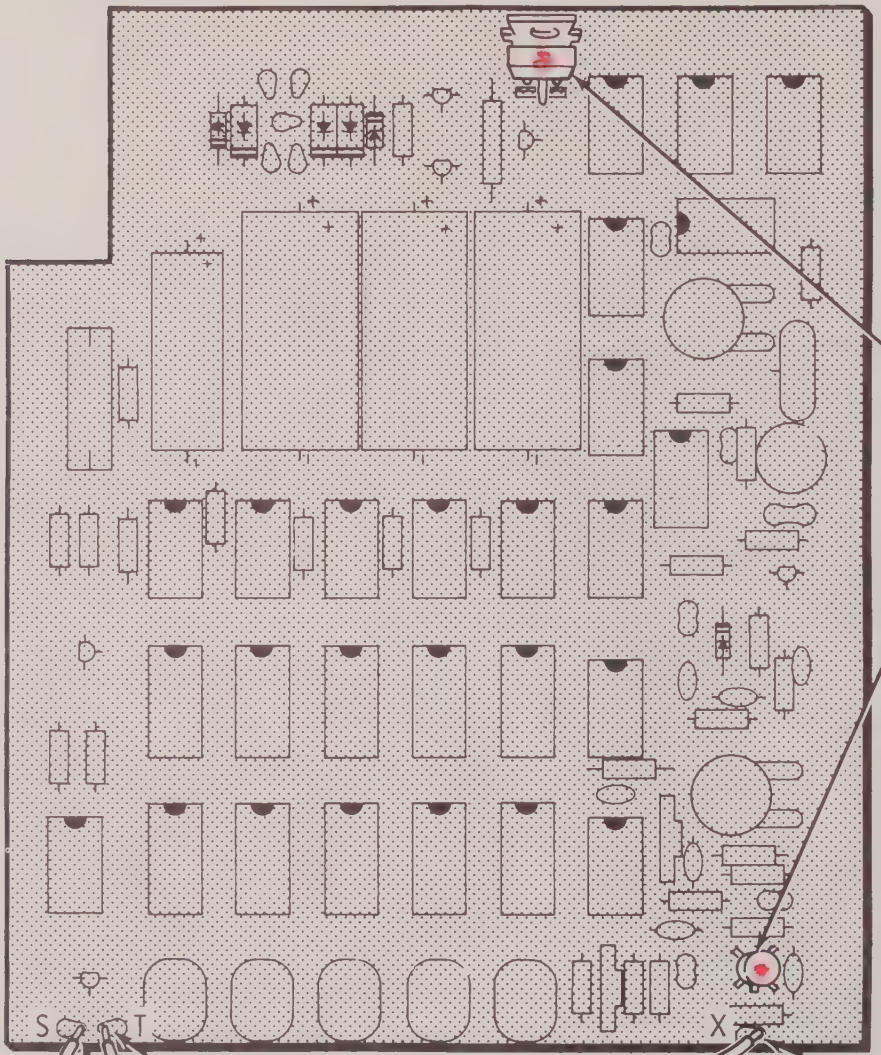
NOTE: This transistor may be one of the three types shown below. Determine which type you received and insert the transistor leads into the corresponding C, B, and E holes in the circuit board as shown. Then solder the leads to the foil and cut off the excess lead length.



PROCEED TO PICTORIAL 12.

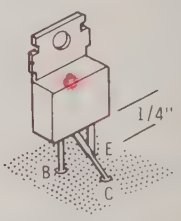


PICTORIAL 11

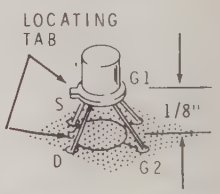


START

( ) Transistor TA2911 (#417-175) at Q8.



( ) Transistor 40670 (#417-240) at Q1. Install the transistor 1/8" above the circuit board as shown.



NOTE: When preparing wires, cut them to the indicated length and remove 1/4" of insulation from the wire ends. Solder each wire as it is installed.

( ) - 2" black wire at X.

( ) 2-1/2" brown wire at T.

( ) 2-1/2" brown wire at S.

( ) Make sure all connections are soldered, and cut off any excess leads. Compare the foil areas with the foil views on Page 51 to be sure there are no solder bridges.

PROCEED TO PICTORIAL 13.

PICTORIAL 12

HEATHKIT

START

( ) Turn the circuit board over and position it as shown.

NOTE: Prepare and install the following wires. Solder the wires to this side (unscreened side) of the circuit board as they are installed.

( ) 6-1/2" orange wire at F.

( ) 6-1/4" black wire at E.

( ) 5-1/2" small red wire at D.

( ) 5" violet wire at G.

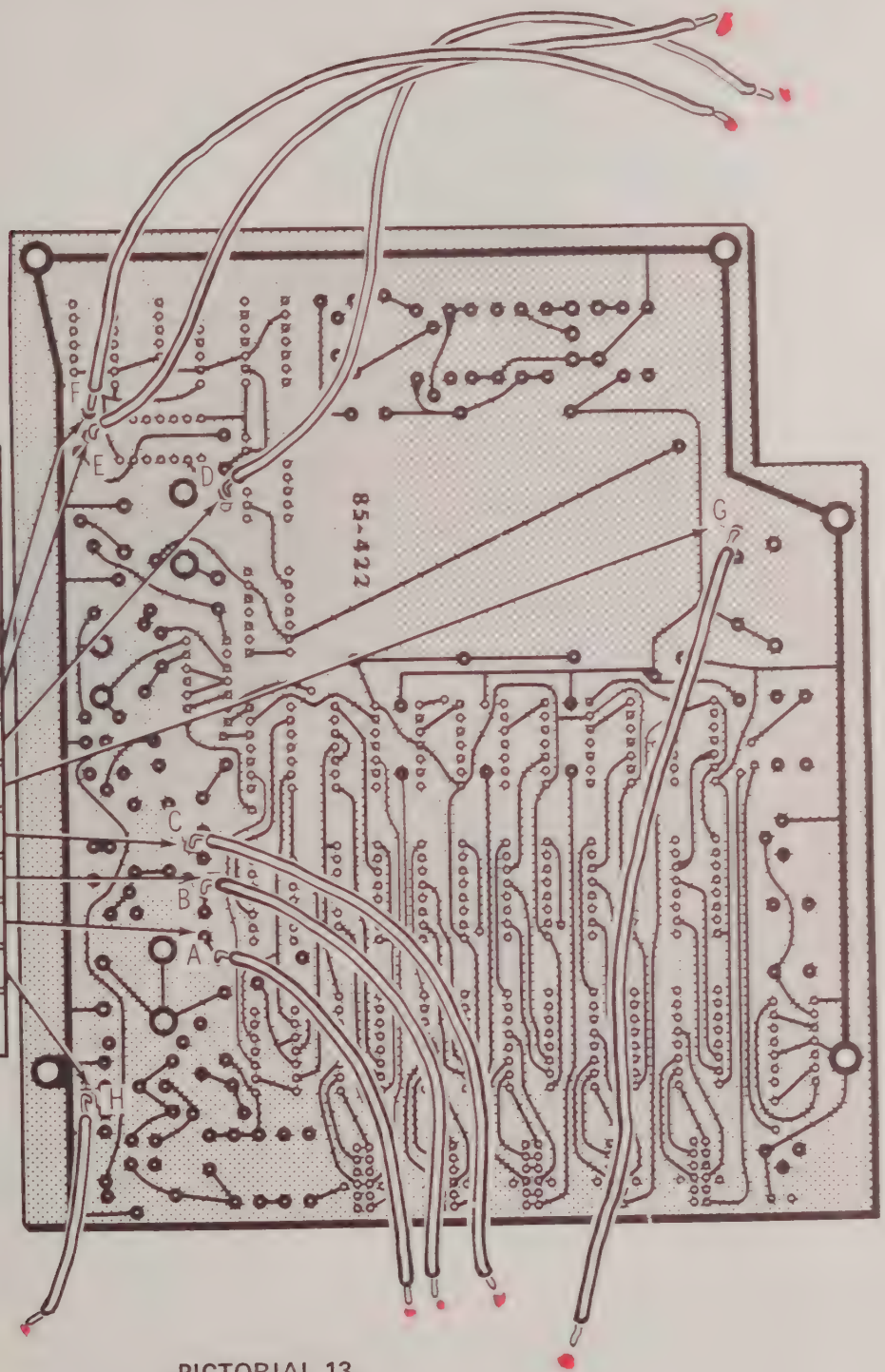
( ) 3-3/4" yellow wire at C.

( ) 3-3/4" green wire at B.

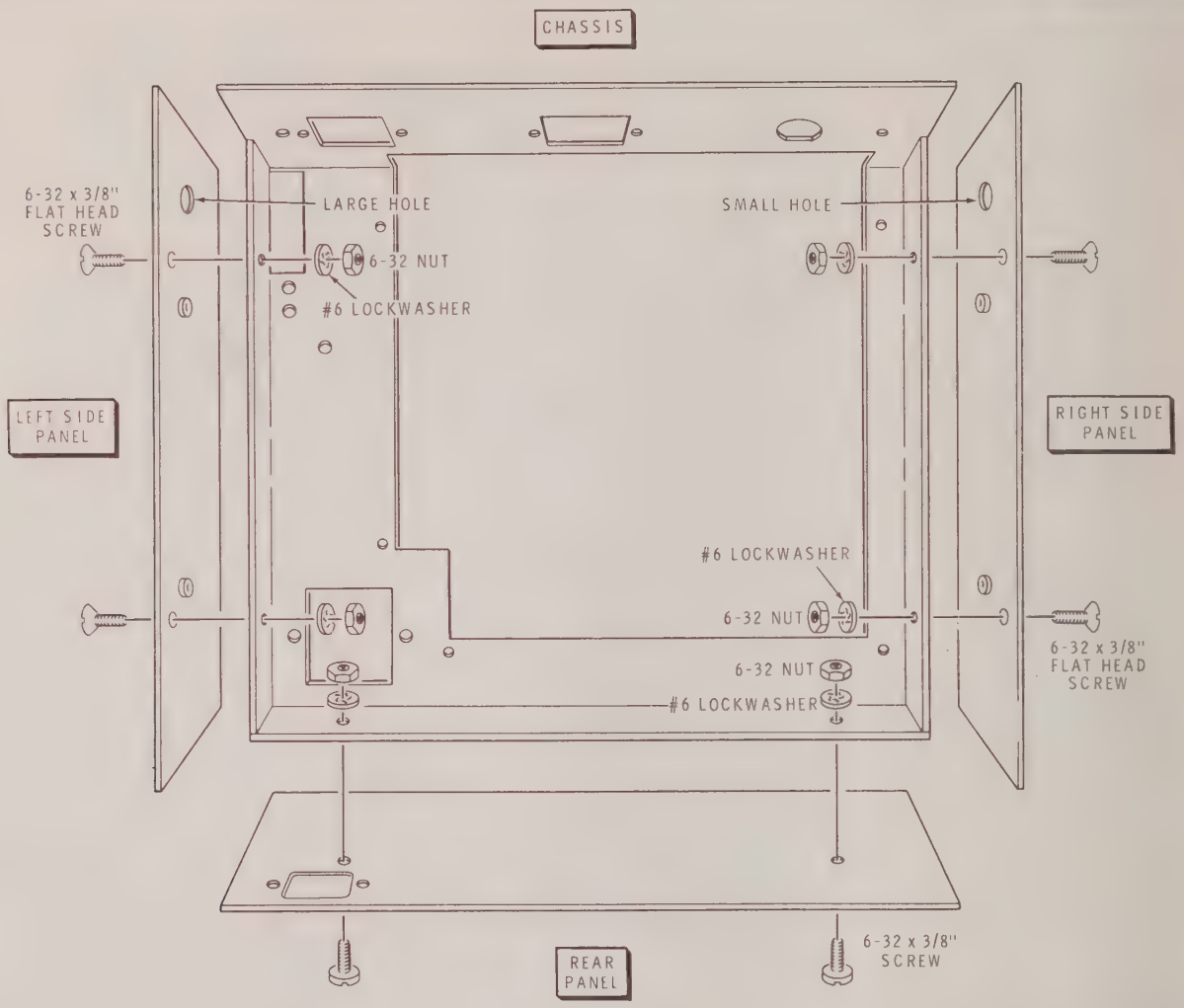
( ) 3-1/4" brown wire at A.

( ) 1-3/4" yellow wire at H.

( ) Temporarily set the circuit board aside and proceed to Page 18.



PICTORIAL 13



Detail 14A

CHASSIS PARTS MOUNTING

Refer to Pictorial 14 (fold-out from Page 23) for the following steps.

Refer to Detail 14A for the next four steps.

( ) Locate the chassis and position it as shown.

NOTES:

1. The Heath Company has provided a plastic nut starter with this kit. Use this nut starter to hold and start 6-32 and 4-40 nuts on screws. Refer to the "Kit Builders Guide" for further information.

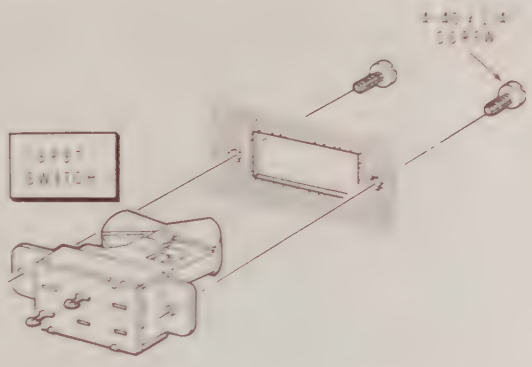
2. The term "hardware" will be used to refer to the screws, nuts, and lockwashers when parts are being mounted in some of the following steps. The phrase "Use 6-32 x 3/8" flat head hardware," for example, means to use a 6-32 x 3/8" flat head screw, one or more #6 lockwashers, and a 6-32 nut. Refer to the Detail called out in the step for the correct number of lockwashers to use and the correct way to install the hardware.

(•) Mount the right side panel on the chassis as shown with 6-32 x 3/8" flat head hardware.

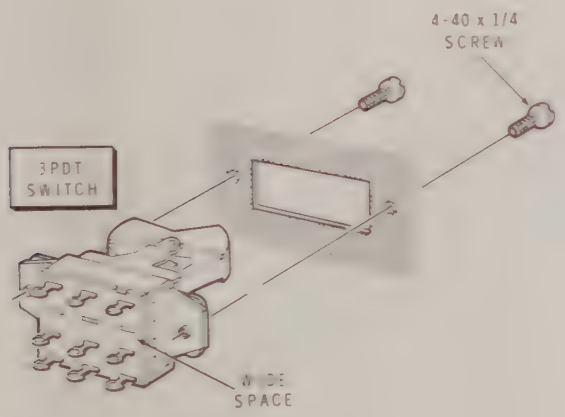
(•) Mount the left side panel on the chassis as shown with 6-32 x 3/8" flat head hardware.

(•) Mount the rear panel on the chassis as shown with 6-32 x 3/8" hardware. NOTE: Do not use flat head screws here.

(•) Refer to Detail 14B and mount the 3PDT switch at AA as shown. Use two 4-40 x 1/4" screws.



Detail 14C



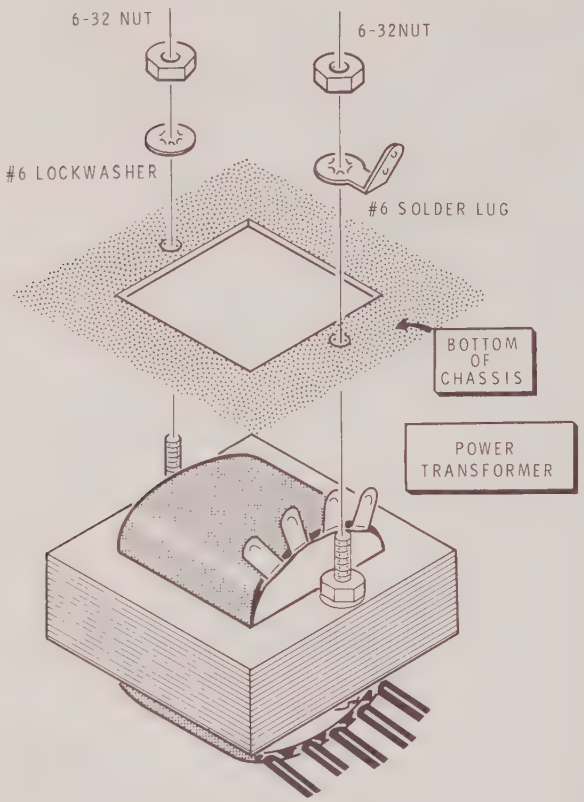
Detail 14B

(•) Refer to Detail 14C and mount the SPST switch at AB as shown. Use two 4-40 x 1/4" screws.

(•) Refer to Detail 14D and mount the fuseholder at AC as shown. Use 6-32 x 3/8" hardware.

(•) Install the 1/4-ampere, slow-blow fuse into the fuseholder.

Detail 14D

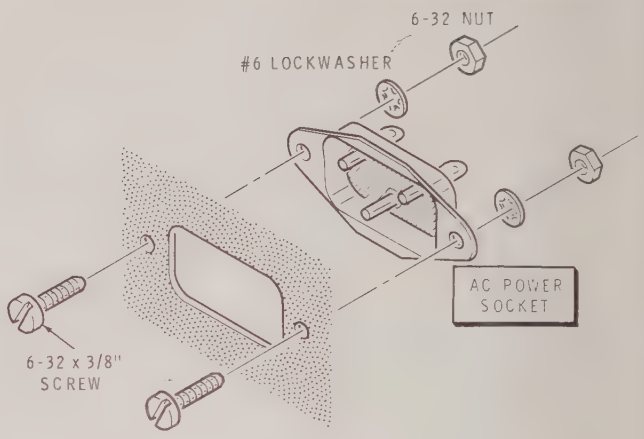


Detail 14E

(•) Refer to Detail 14E and mount the power transformer at AD. Use a 6-32 nut and a #6 solder lug at AF and a 6-32 nut and a #6 lockwasher on the remaining mounting screw.

(•) Refer to Detail 14F and mount the ac power socket at AE as shown. Use 6-32 x 3/8" hardware.

(•) Refer to Pictorial 14 and mount the circuit board on the chassis as shown. Use 4-40 x 1/4" hardware. Be sure no wires are pinched between the circuit board and chassis.



Detail 14F

Refer to Pictorial 15 for the following steps.

Connect seven of the circuit board wires to switch AA as follows:

(•) Black wire coming from E to lug 1 (S-1).

(•) Brown wire coming from A to lug 2 (S-1).

(•) Red wire coming from D to lug 3 (S-1).

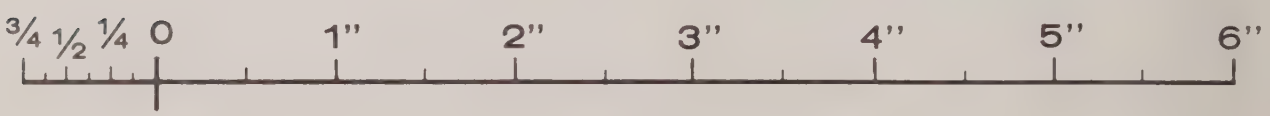
(•) Orange wire coming from F to lug 4 (S-1).

(•) Yellow wire coming from C to lug 5 (S-1).

(•) Green wire coming from B to lug 6 (S-1).

(•) Violet wire coming from G to lug 8 (S-1).

NOTE: When wiring this kit you may find it easier to prepare the lengths of hookup wire ahead of time as in the following step. To prepare a wire, cut it to the indicated length and cut 1/4" of insulation from each end. The wires are listed in the order in which they will be used.



Prepare the following wires:

5-1/4" blue
6-1/4" gray

( ) Connect the 5-1/4" blue wire to lug 7 of switch AA (S-1). Route the loose end as shown. It will be connected later.

( ) Connect the 6-1/4" gray wire to lug 9 of switch AA (S-1). Route the loose end as shown. It will be connected later.

Prepare the following large red wires:

5-1/2"
1-1/2"
4-3/4"
2-1/2"
1-1/4"

( ) Connect a 5-1/2" large red wire from lug 2 of switch AB (S-1) to lug 4 of the power transformer AD (NS).

( ) Connect a 1-1/2" large red wire from lug 1 of switch AB (S-1) to lug 2 of fuseholder AC (S-1).

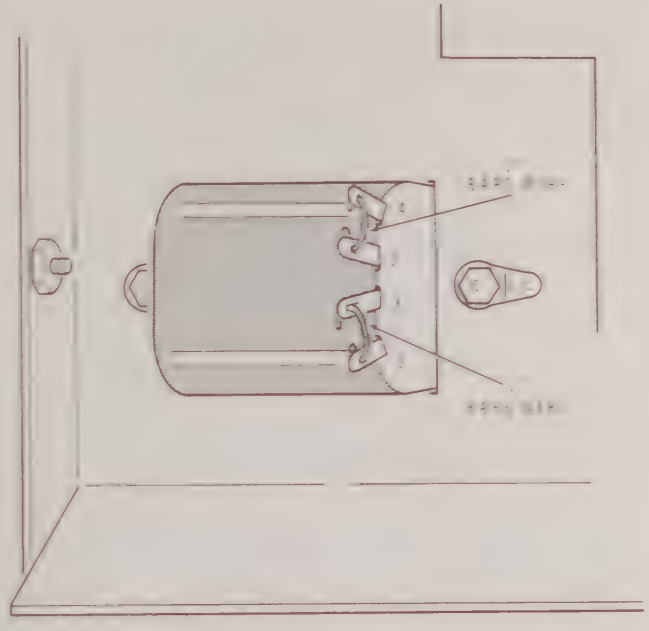
( ) Connect a 4-3/4" large red wire from lug 1 of fuseholder AC (S-1) to lug 1 of ac power socket AE (S-1).

( ) Connect a 2-1/2" large red wire from solder lug AF (S-1) to lug 2 of ac power socket AE (S-1). Route the wire as shown.

( ) Connect a 1-1/4" large red wire from lug 3 of ac power socket AE (S-1) to lug 1 of the power transformer AD (NS).

ALTERNATE LINE VOLTAGE WIRING

Two sets of line voltage wiring instructions are given below, one for 120 Vac line voltage and the other for 240 Vac line voltage. In the U.S.A. 120 Vac is most often used, while in foreign countries 240 Vac is more common. USE ONLY THE INSTRUCTIONS THAT AGREE WITH THE LINE VOLTAGE IN YOUR AREA.



Detail 15A

120 Vac Wiring

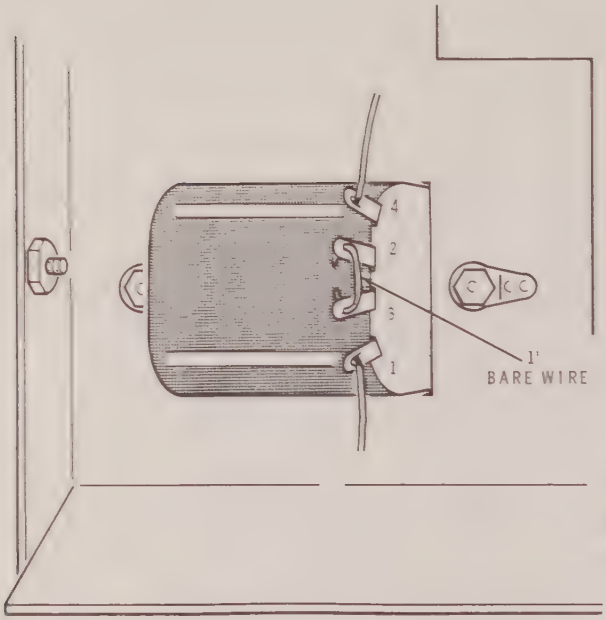
Refer to Detail 15A for the following steps.

( ) Remove 1" of insulation from a large red wire, and then cut off the 1" bare end.

( ) Connect this bare wire between lug 1 (S-2) and lug 3 (S-1) of the power transformer.

( ) Remove another 1" of insulation from a large red wire, and cut off the 1" bare end.

( ) Connect this bare wire between lug 2 (S-1) and lug 4 (S-2) of the power transformer.



Detail 15B

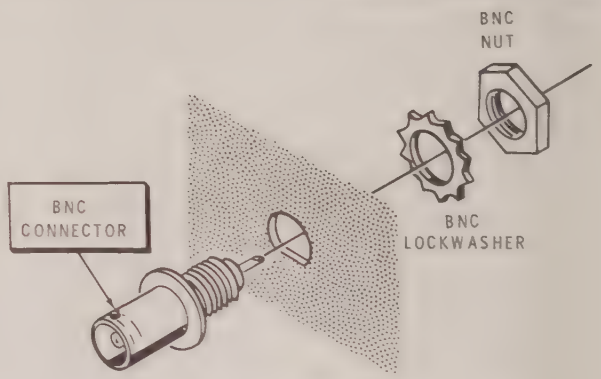
240 Vac Wiring

Refer to Detail 15B for the following steps.

( ) Solder the connection at lug 4 (S-1) of the power transformer.

( ) Solder the connection at lug 1 (S-1) of the power transformer.

( ) Remove 1" of insulation from a large red wire, and then cut off the 1" bare end.



Detail 16A

( ) Connect this bare wire between lug 3 (S-1) and lug 2 (S-1) of the power transformer.

( ) Turn the chassis over and set it aside temporarily.

FRONT PANEL ASSEMBLY

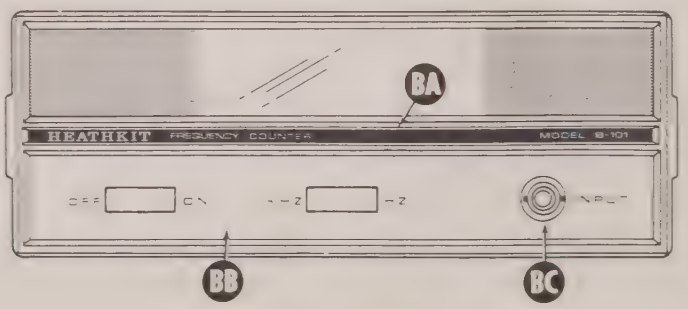
Refer to Pictorial 16 for the following steps.

( ) Position the front panel as shown in the Pictorial.

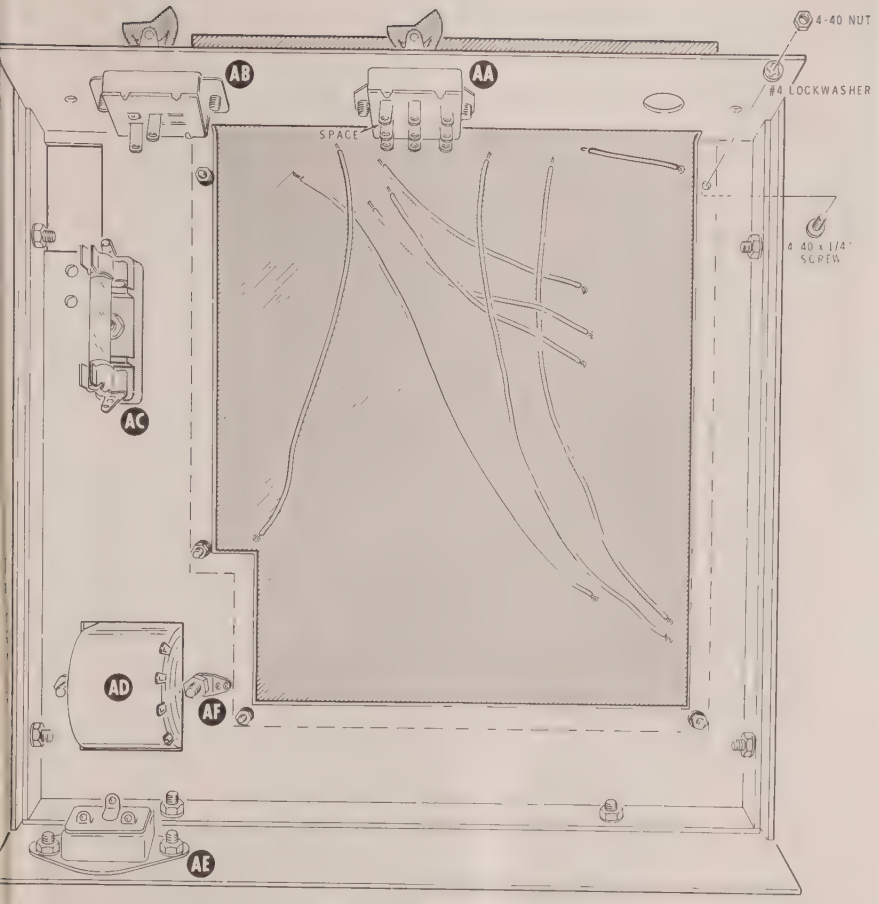
( ) Remove the protective backing from the "Heathkit" label and install the label at BA.

( ) Remove the protective backing from the control label and install the label at BB.

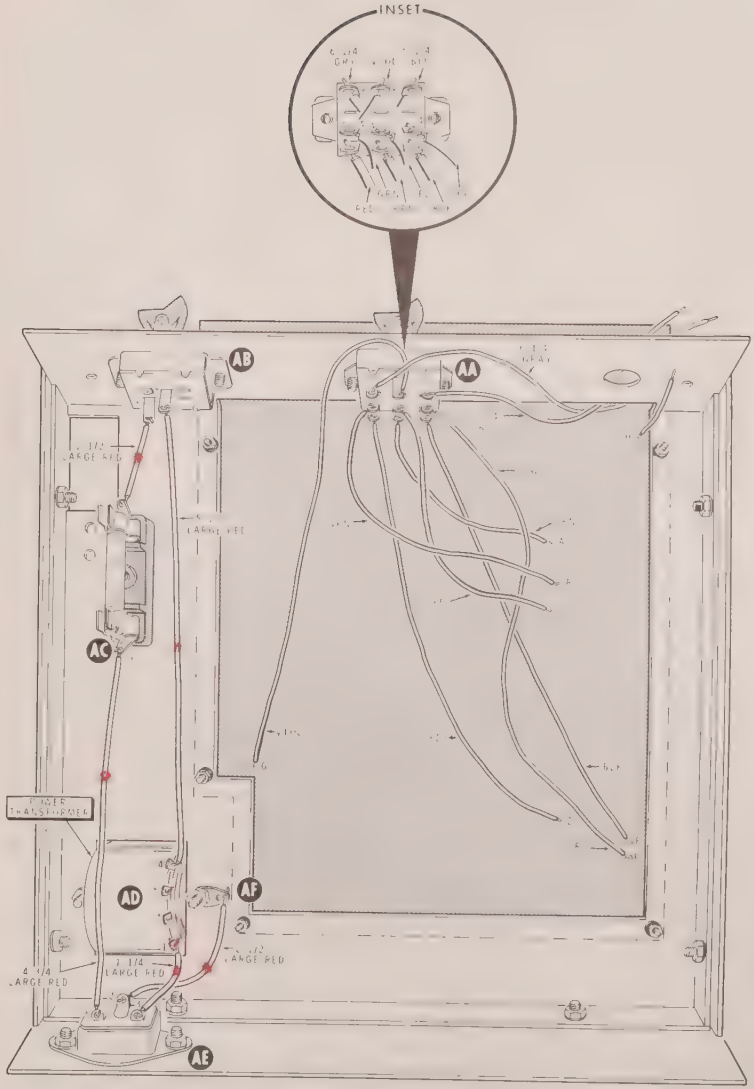
( ) Refer to Detail 16A and mount the BNC connector at BC. Use the lockwasher and nut supplied with the connector.



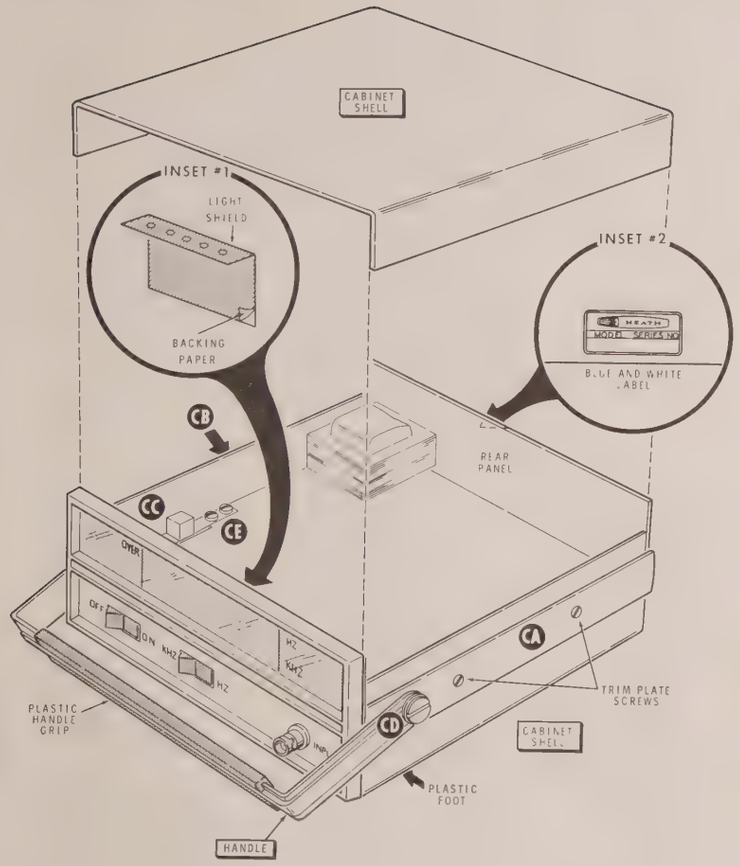
PICTORIAL 16



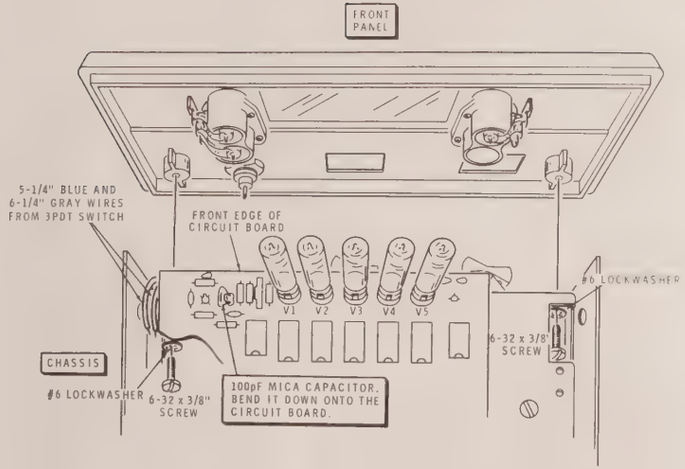
PICTORIAL 14



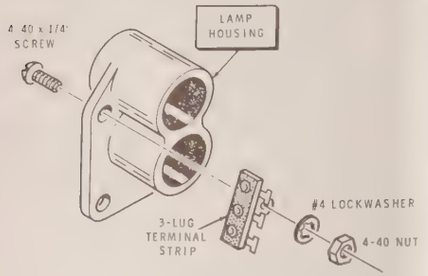
PICTORIAL 15



PICTORIAL 21



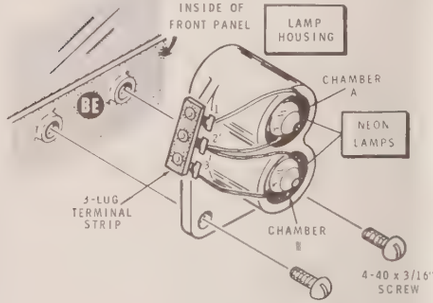
PICTORIAL 18



Detail 17C

( ) Refer to Detail 17C and mount a 3-lug terminal strip to the remaining lamp housing as shown. Use 4-40 x 1/4" hardware.

Refer to Detail 17D for the folllowing steps.

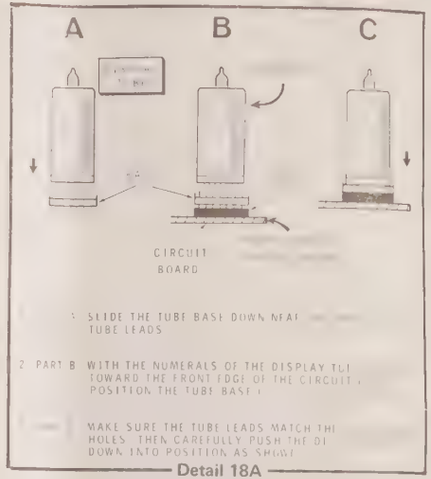


Detail 17D

( ) Mount a lamp housing at BE with two 4-40 x 3/16" screws. Do not overtighten these screws.

( ) Install a neon lamp into chamber A of this lamp housing. Connect one lead of the lamp to lug 1 (NS) and the other lead to lug 2 (NS) of the attached 3-lug terminal strip.

( ) Install the remaining neon lamp into chamber B. Connect one lead of the lamp to lug 2 (NS) and the other lead to lug 3 (NS) of the terminal strip.


A
B
C
CIRCUIT BOARD
1 SLIDE THE TUBE BASE DOWN NEAR TUBE LEADS
2 PART B WITH THE NUMERALS OF THE DISPLAY TU TOWARD THE FRONT EDGE OF THE CIRCUIT POSITION THE TUBE BASE
MAKE SURE THE TUBE LEADS MATCH THI HOLES. THEN CAREFULLY PUSH THE DI DOWN INTO POSITION AS SHOWN

Detail 18A

( ) Set the front panel aside temporarily.

Refer to Pictorial 18 for the following steps.

( ) Position the chassis as shown.

FRONT PANEL MOUNTING

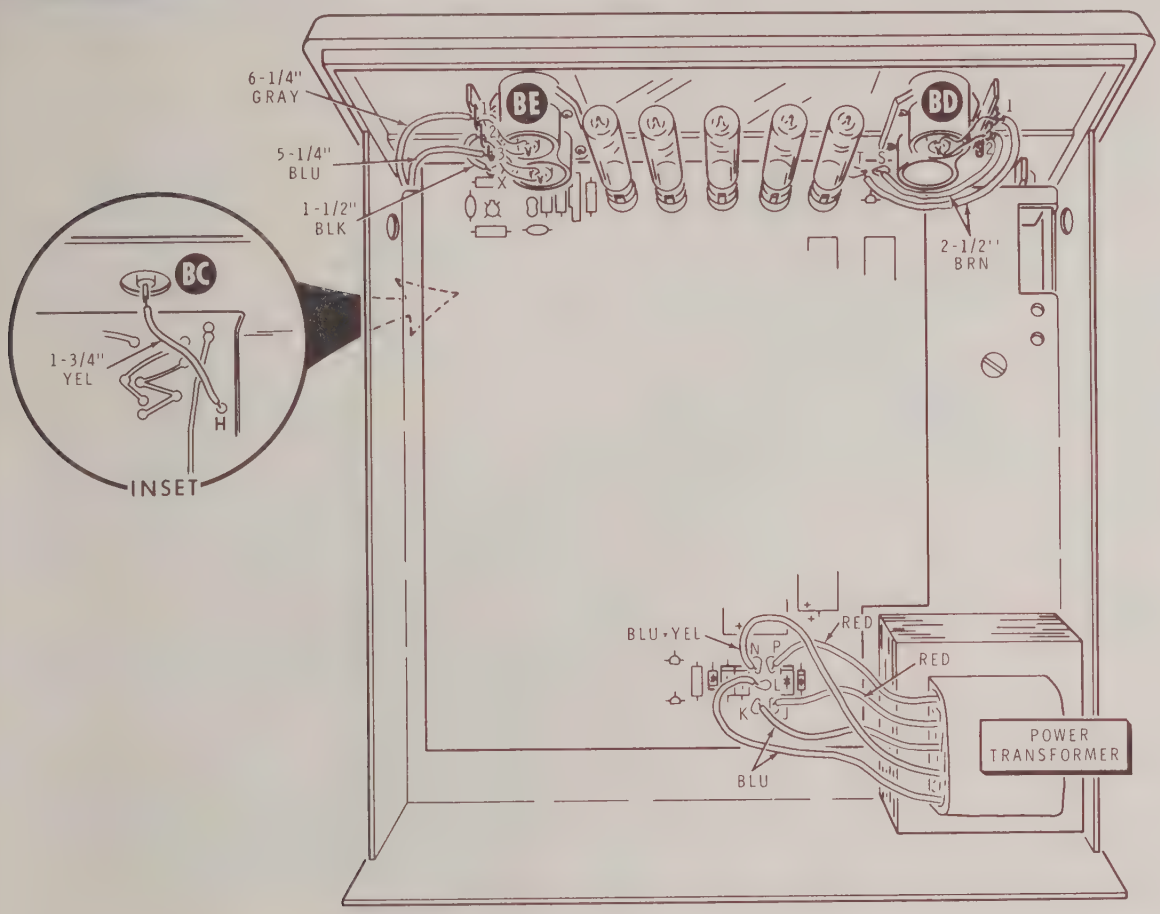
Install display tubes at the following positions as instructed in Detail 18A.

( ) V1
( ) V2
( ) V3
( ) V4
( ) V5

( ) Refer to Pictorial 18 and route the 5-1/4" blue and the 6-1/4" gray wires (coming from switch AA) as shown.

( ) Carefully bend the indicated 100 pF mica capacitor over so it lies down on the circuit board as shown.

( ) Carefully mount the front panel to the chassis. Use two #6 lockwashers and two 6-32 x 3/8" screws.



PICTORIAL 19

FINAL WIRING

Refer to Pictorial 19 for the following steps.

( ) Connect the 2-1/2" brown wire coming from S to lug 2 of terminal strip BD (S-2).

( ) Connect the 2-1/2" brown wire coming from T to lug 1 of terminal strip BD (S-2).

( ) Connect the 1-1/2" black wire coming from X to lug 2 of terminal strip BE (S-3).

( ) Connect the 5-1/4" blue wire coming from lug 7 of the 3 PDT switch to lug 3 of terminal strip BE (S-2).

( ) Connect the 6-1/4" gray wire coming from lug 9 of the 3 PDT switch to lug 1 of terminal strip BE (S-2).

Connect the remaining transformer leads to the following points on the circuit board. Solder each lead as it is installed.

( ) Either red to P.

( ) Remaining red to J.

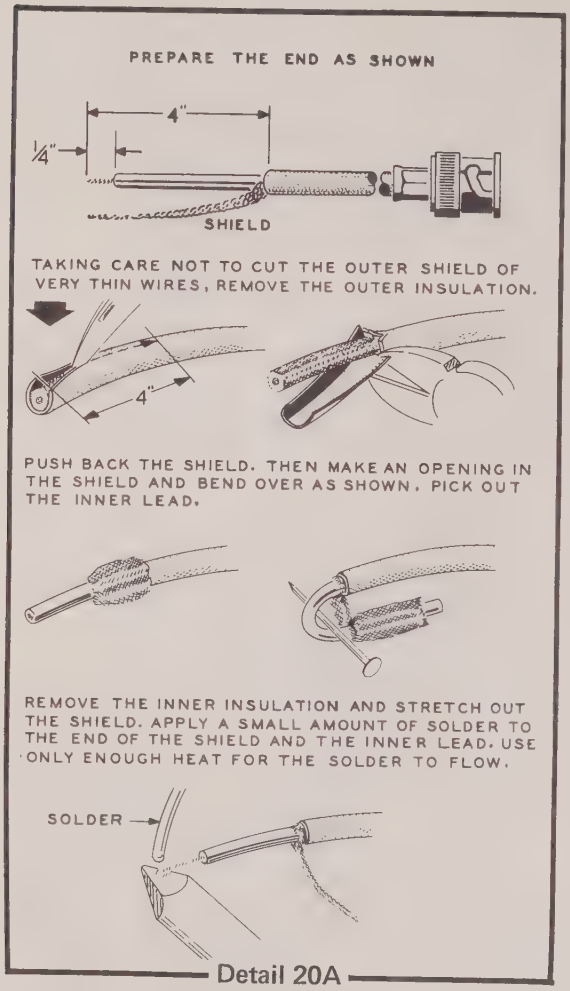
( ) Blue-yellow to N.

( ) Either blue to L.

( ) Remaining blue to K.

( ) Turn the Counter over and connect the 1-1/2" yellow wire coming from H to the front panel BNC connector BC (S-1). See the inset drawing.

( ) Set the Counter aside temporarily.

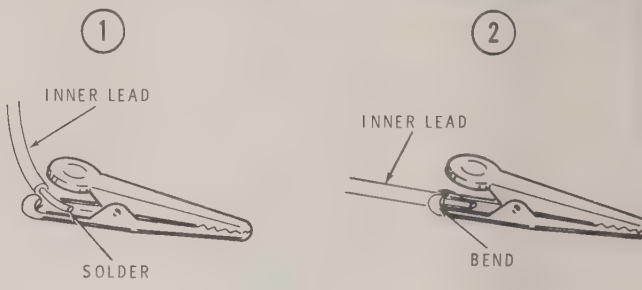

PREPARE THE END AS SHOWN
4"
¼"
SHIELD
TAKING CARE NOT TO CUT THE OUTER SHIELD OF VERY THIN WIRES, REMOVE THE OUTER INSULATION.
4"
PUSH BACK THE SHIELD. THEN MAKE AN OPENING IN THE SHIELD AND BEND OVER AS SHOWN. PICK OUT THE INNER LEAD.
REMOVE THE INNER INSULATION AND STRETCH OUT THE SHIELD. APPLY A SMALL AMOUNT OF SOLDER TO THE END OF THE SHIELD AND THE INNER LEAD. USE ONLY ENOUGH HEAT FOR THE SOLDER TO FLOW.
SOLDER

Detail 20A

TEST CABLE ASSEMBLY

Refer to Pictorial 20 for the following steps.

( ) Refer to Detail 20A and prepare the indicated end of the cable assembly.

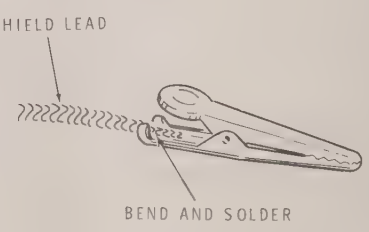


Detail 20B

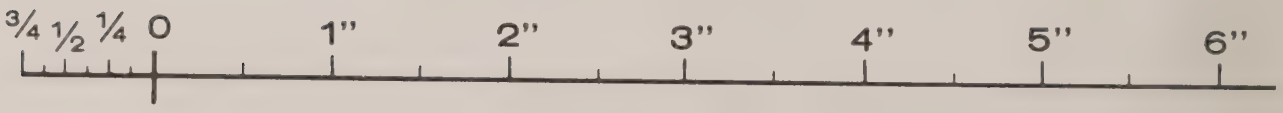
( ) Refer to Pictorial 20 and push a rubber insulator onto the inner lead and the shield lead of the cable as shown.

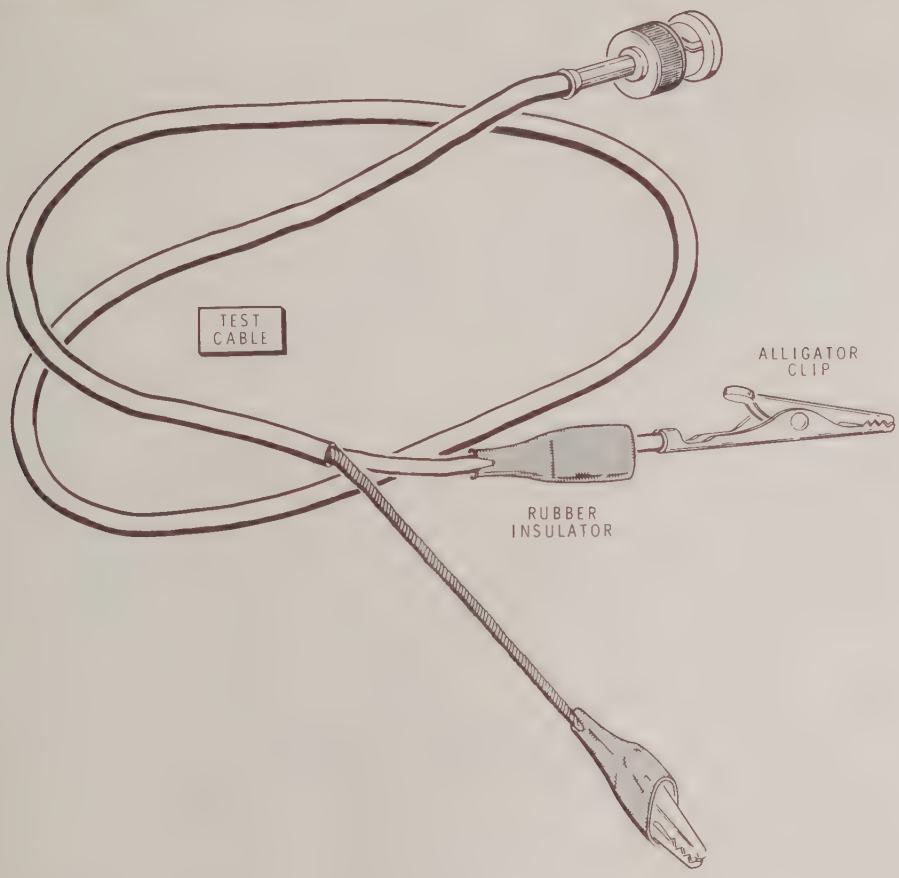
( ) Refer to Detail 20B and install an alligator clip on the inner lead of the cable as shown in parts 1 and 2 of the Detail.

( ) Refer to Detail 20C and install an alligator clip on the shield lead of the cable as shown. Then push the rubber insulator down over the alligator clips.



Detail 20C





PICTORIAL 20

INITIAL CHECKOUT

The purpose of the "Initial Checkout" section of the Manual is to make sure your Counter operates properly and will not be damaged as the result of a wiring error. A transistor or integrated circuit, for example, could be destroyed instantly by a short circuit that causes excessive current.

( ) Inspect the circuit board for improperly soldered connections that may have been missed and not soldered. Also check for solder bridged across two or more circuit board foils, which would cause a short circuit.

( ) Examine all chassis-mounted parts to make sure they are properly mounted and connected.

( ) Be sure no bare wires are touching any components or the chassis.

Refer to Figure 2 for the following steps.

NOTE: The line cord is equipped with a polarized plug. Therefore, a plug adapter has been included in case your house wiring is not equipped with polarized sockets. When you use this adapter, the green wire should be connected to a screw that is connected to earth ground.

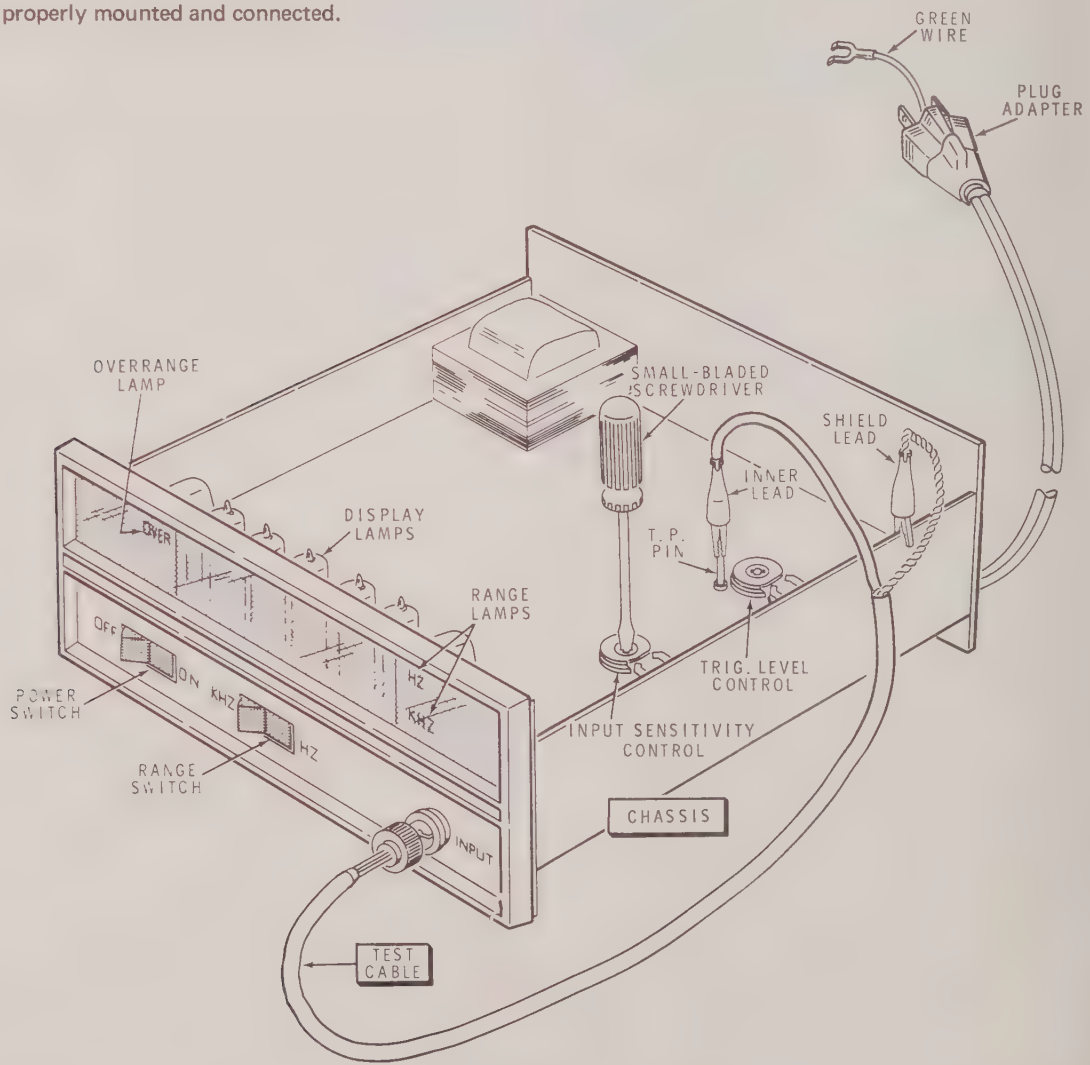


Figure 2

( ) Push the POWER switch to the OFF position.

NOTE: In the following steps, if the Counter does not operate as described, immediately unplug the line cord and refer to the "In Case of Difficulty" section of the Manual on Page 37. Then correct the problem before proceeding with the "Initial Checkout."

CAUTION: High voltages are exposed in the Counter when the line cord is plugged into the Counter and an ac outlet.

( ) Plug the line cord into the Counter and an ac outlet of the proper voltage (120 or 240 Vac, depending upon the connection of the power transformer) and push the POWER switch to the ON position. The five display tubes and one range-indicator lamp should light. Do not be concerned if the display tubes display random numbers at this time.

( ) Unplug the line cord.

( ) Connect the test cable to the INPUT connector as shown.

( ) Connect the shield lead of the test cable to the chassis and the inner lead to the test point (T.P.) pin.

( ) Push the RANGE switch to the Hz position.

( ) With a small-bladed screwdriver, rotate both the INPUT SENSITIVITY control and the TRIG LEVEL control fully counterclockwise.

( ) Plug in the line cord and slowly turn the INPUT SENSITIVITY control clockwise until the display tubes and range lamp indicate approximately 10,000 Hz. NOTE: If your Counter performs as described, disconnect the line cord and proceed to "Final Assembly." If it does not perform as described, or if the OVER (overrange) or kHz lamps are lit, disconnect the line cord and refer to the "In Case of Difficulty" section on Page 37 and correct the problem before proceeding.

FINAL ASSEMBLY

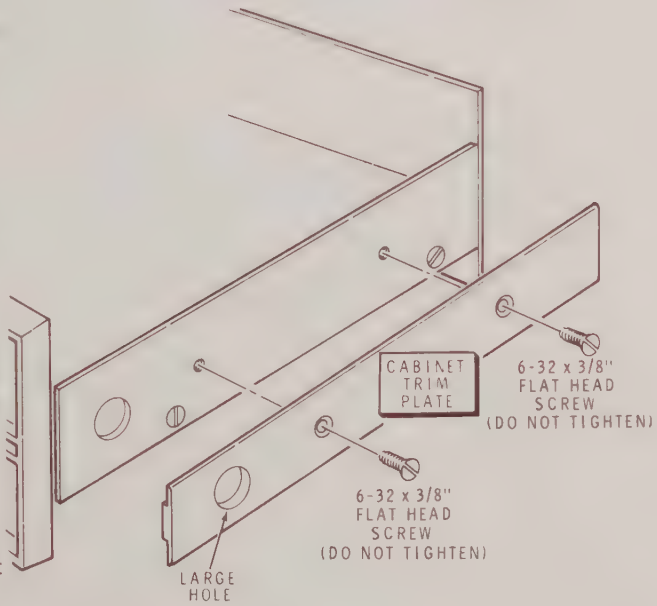
Refer to Pictorial 21 (fold-out from Page 24) for the following steps.

( ) Be sure the line cord is unplugged.

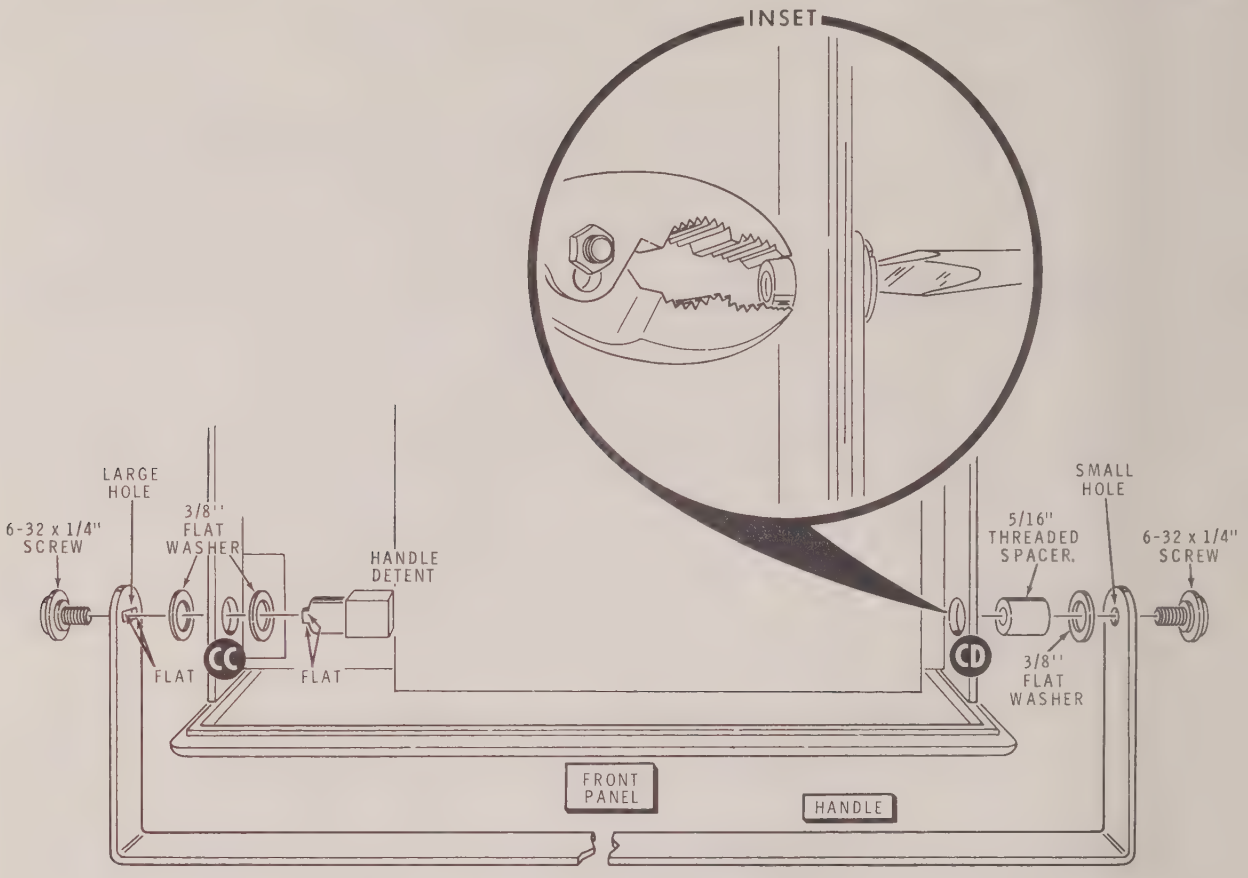
( ) Disconnect the test cable and set it aside temporarily.

( ) Refer to Detail 21A and loosely mount a cabinet trim plate at CA as shown. Use two 6-32 x 3/8" flat head screws.

( ) Likewise, mount the remaining cabinet trim plate at CB. Use two 6-32 x 3/8" flat head screws.



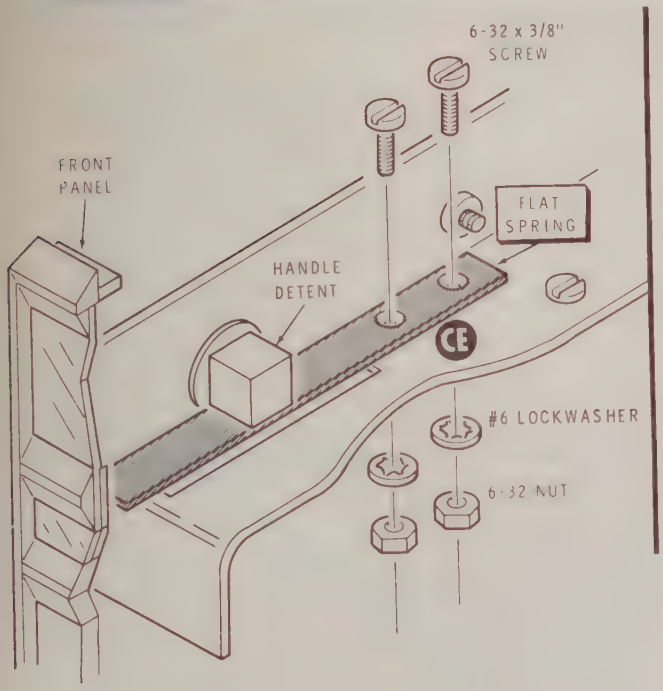
Detail 21A



Detail 21B

( ) Refer to Detail 21B and position the small hole in the handle next to hole CD in the chassis. Use a 6-32 x 1/4" screw, a 3/8" flat washer, and a 6-32 x 5/16" threaded spacer as shown in the inset drawing.

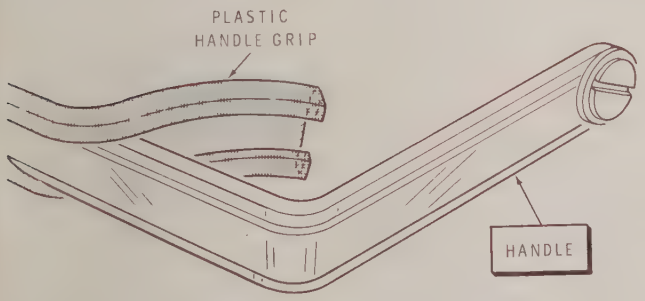
( ) Secure the other end of the handle to the chassis at hole CC. Use a 6-32 x 1/4" screw, two 3/8" flat washers, and a handle detent as shown.



Detail 21C

( ) Refer to Detail 21C and mount the flat spring at CE. Use two sets of 6-32 x 3/8" hardware.

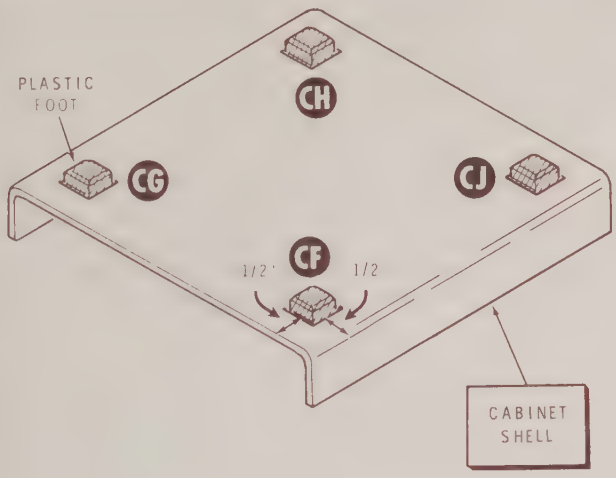
( ) Refer to Detail 21D and install the plastic handle-grip onto the handle as shown.



Detail 21D

( ) Refer to Pictorial 21 and be sure the display tubes are sitting straight up in the tube sockets.

( ) Fold the light shield as shown in inset drawing #1.



Detail 21E

( ) Carefully peel the backing paper from the light shield and press the light shield onto the display tubes to hold them in position.

( ) Refer to Detail 21E. Remove the protective backing from four plastic feet and mount them to a cabinet shell as shown at CF, CG, CH, and CJ.

Install the cabinet shells as instructed in the following steps.

( ) Loosen the four screws holding the two cabinet trim plates.

( ) Position the cabinet shell with plastic feet onto the chassis bottom and the other cabinet shell onto the chassis top as shown in Pictorial 21.

( ) Tighten the cabinet trim plate screws so that the trim plates hold the cabinet shells in position.

NOTE: The blue and white label shows the model number and production series number of your kit. Refer to these numbers in any communications with the Heath Company; this assures you that you will receive the most complete and up-to-date information in return.

( ) Carefully peel the backing paper from the blue and white identification label and press the label onto the back panel as shown in inset drawing #2.

This completes the assembly of your Counter. Proceed to the "Calibration" section.

CALIBRATION

( ) Turn the Counter on and allow it to warm up for 30 minutes.

( ) Locate the 1/8" x 1" metal strip. This is the alignment tool tip. With a pair of pliers, insert the tip into the small end of the nut starter so that it extends 1/8" from the end of the starter as shown in Figure 3. Use this tool for all calibration adjustments.

( ) Remove the top cabinet shell.

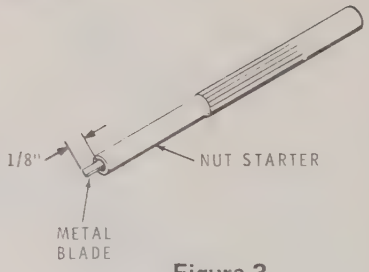


Figure 3

NOTE: The remaining portion of the calibration is divided into two sections: "Without Instruments" and "With Instruments." the "With Instruments" section requires the use of a frequency counter and/or a frequency generator. Choose one of the two sections and perform only the steps in that section.

Without Instruments

CLOCK

( ) Remove the test cable from the counter INPUT connector, if it is not already done.

( ) Tune a standard broadcast (AM) receiver to any station.

( ) Place the antenna of the receiver near the oscillator crystal in the Counter. See Figure 4.

( ) Adjust the variable CAL capacitor for a null (Minimum sound or zero beat) from the receiver.

TIME BASE CLOCK OSCILLATOR ADJUSTMENT TO STATION WWV

Tune a Communications Receiver, using its "AM" Mode, to the highest frequency WWV broadcast station (25, 20, 15, 10 or 5 MHz) that will produce a relatively noise-free signal and constant S meter indication. Attach an insulated wire (not shielded) to the receiver antenna and lay the other end of the wire near the IB-101 oscillator section (IC-25).

When WWV transmits carrier only (no modulation) the 1 MHz clock signal will beat with the clock's multiple WWV signal and the difference frequency will be heard from the receiver. Adjust the IB-101 CAL capacitor for a zero beat in the receiver. Note the reading on S meter of the receiver and continue to adjust this capacitor for the most stable S meter indication and zero beat from the receiver.

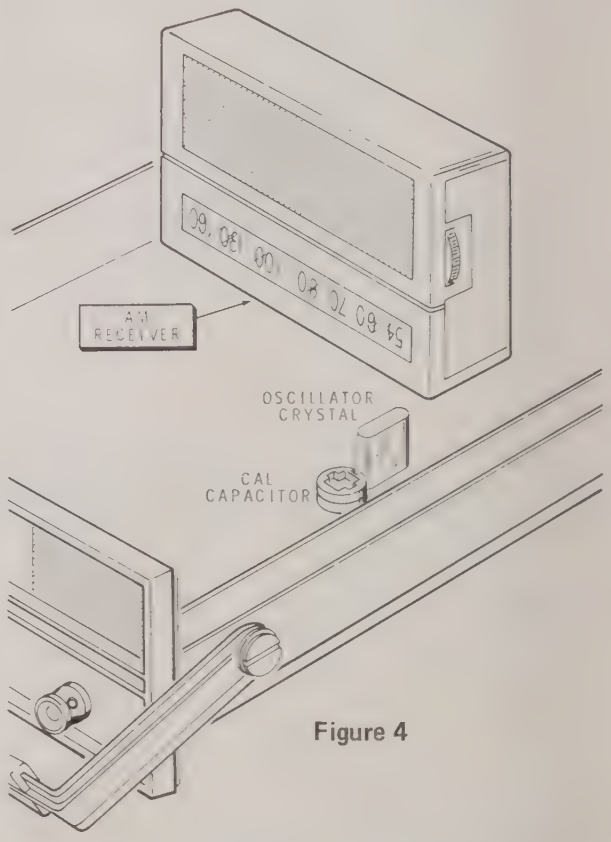


Figure 4

The receiver antenna and/or the IB-101 wire coupling to the receiver may require adjusting to produce a satisfactory S meter indication.

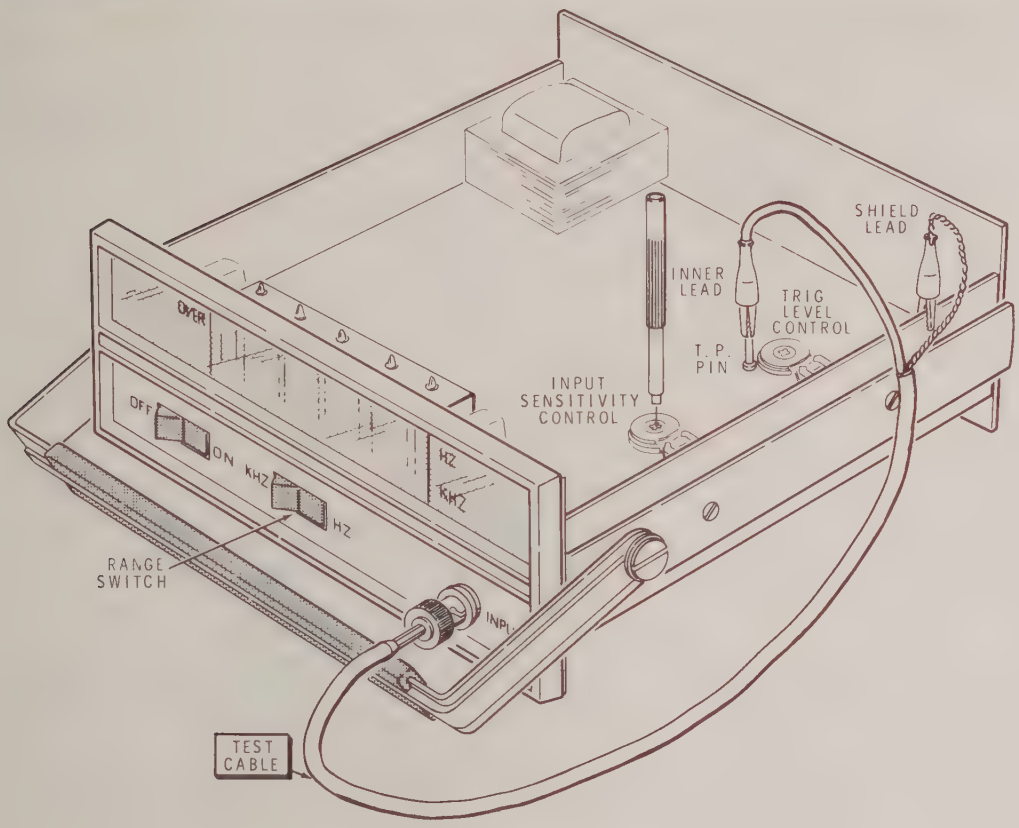


Figure 5

INPUT SENSITIVITY

Refer to Figure 5 for the following steps.

1. ( ) Connect the test cable to the input connector of the Counter.

2. ( ) Connect the shield lead of the test cable to the chassis and the inner lead to the test point (TP) pin.

3. ( ) Push the RANGE switch to the kHz position.

4. ( ) If a reading of 10 kHz is not present, adjust the INPUT SENSITIVITY control until this reading appears.

5. ( ) Turn the TRIG LEVEL control very slowly in a clockwise direction until the 10 kHz reading just disappears or changes to a lower number.

6. ( ) Readjust the INPUT SENSITIVITY control very slowly until the 10 kHz reading is again obtained.

( ) Repeat steps 5 and 6 until the TRIG LEVEL control is turned as far clockwise as possible and the counter still displays 10 kHz.

( ) Turn the Counter off and disconnect the test cable leads.

( ) Replace the top cabinet-shell.

This completes the calibration of your Frequency Counter.

With Instruments

CLOCK

Determine which of the following clock calibration methods you will use. Then complete the steps under the appropriate heading.

Calibration With a Frequency Counter and Signal Generator.

Equipment Required:

1. Frequency counter.
2. Signal generator capable of 15 MHz, 250 mV output.

( ) Connect the test leads of the above frequency counter to the output terminals of the signal generator. See Figure 6.

( ) Also connect the test leads of the IB-101 Frequency Counter to the output terminals of the signal generator.

( ) Set the signal generator to 15 MHz at 250 mV output.

( ) Adjust the Model IB-101 variable CAL capacitor until the IB-101 indicates exactly the same frequency as the other frequency counter.

( ) Disconnect the test leads.

The accuracy of this IB-101 counter is now dependent on the accuracy of the other frequency counter.

This completes the calibration of the clock. Proceed to the Input Sensitivity adjustment.

Calibration With a Known Frequency

NOTE: When using this method, it is essential that the known frequency (10 kHz or greater - 15 MHz is ideal) be stable. The accuracy of this type of calibration is dependent on the accuracy in percentage of the known frequency.

( ) Connect a known frequency to the test cable of the Counter.

( ) Push the RANGE switch to the Hz position.

( ) Adjust the variable CAL capacitor until the known frequency is indicated exactly on the Counter.

This completes the calibration of the clock. Proceed to the Input Sensitivity adjustment.

INPUT SENSITIVITY

EQUIPMENT REQUIRED:

10 kHz – 1 MHz generator with an output of 50 mV rms to 1 volt rms continuously variable.

1. ( ) Connect the test cable to the input connector of the Counter. See Figure 7.

2. ( ) Connect the Counter test cable to the output frequency generator.

3. ( ) Select a frequency (between 10 kHz and 1 MHz) and set the generator output voltage to approximately 1 volt rms.

4. ( ) If the Counter is not indicating the frequency, or is indicating incorrectly, adjust the INPUT SENSITIVITY control until the correct frequency display is obtained.

5. ( ) Reduce the generator output voltage until the display becomes unstable or goes to zero.

6. ( ) Slowly readjust the INPUT SENSITIVITY control to again obtain a correct display.

( ) Repeat steps 5 and 6 until the smallest generator output voltage is reached that still produces a correct display.

NOTE: The TRIG LEVEL control is only used as a variable signal source during the "Calibration Without instruments." Therefore it may remain at any setting, since it does not affect the operation of this Frequency Counter.

( ) Turn off the generator and Counter and disconnect the test cable.

( ) Replace the top cabinet shell.

This completes the calibration of your Frequency Counter.

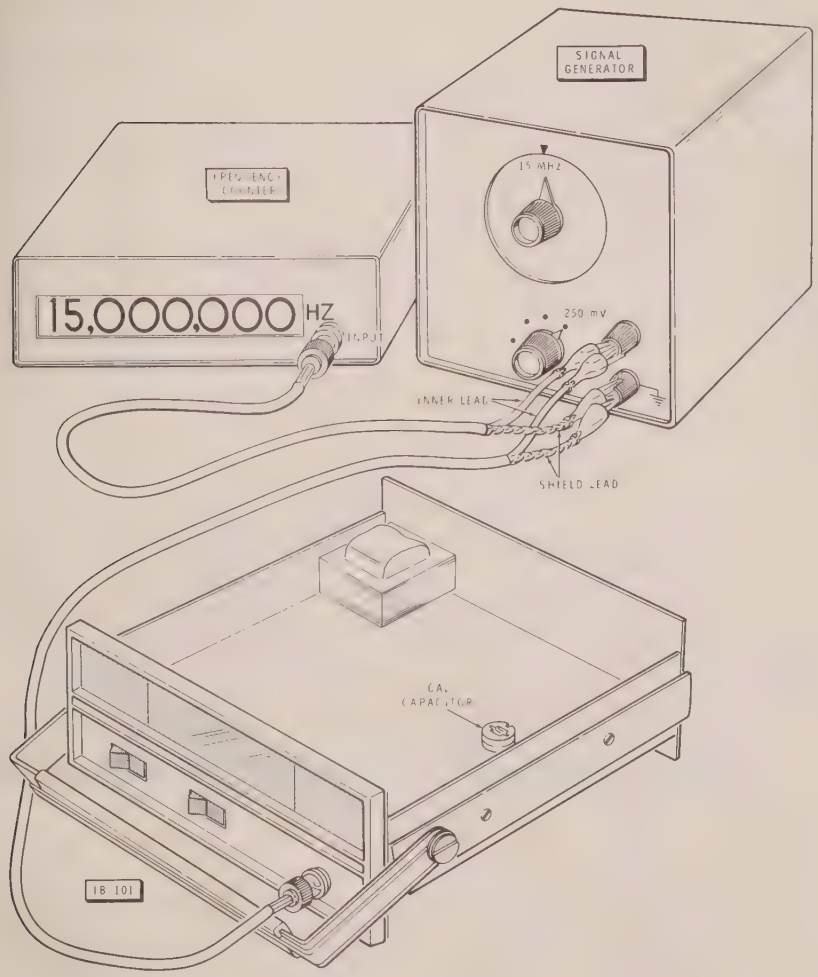


Figure 6

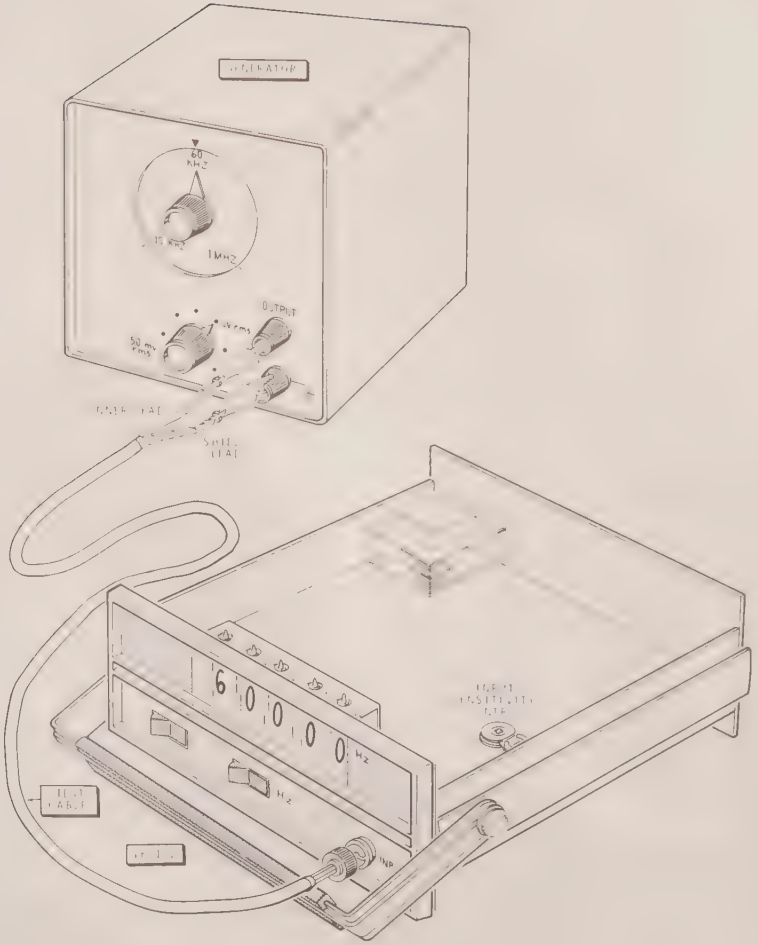
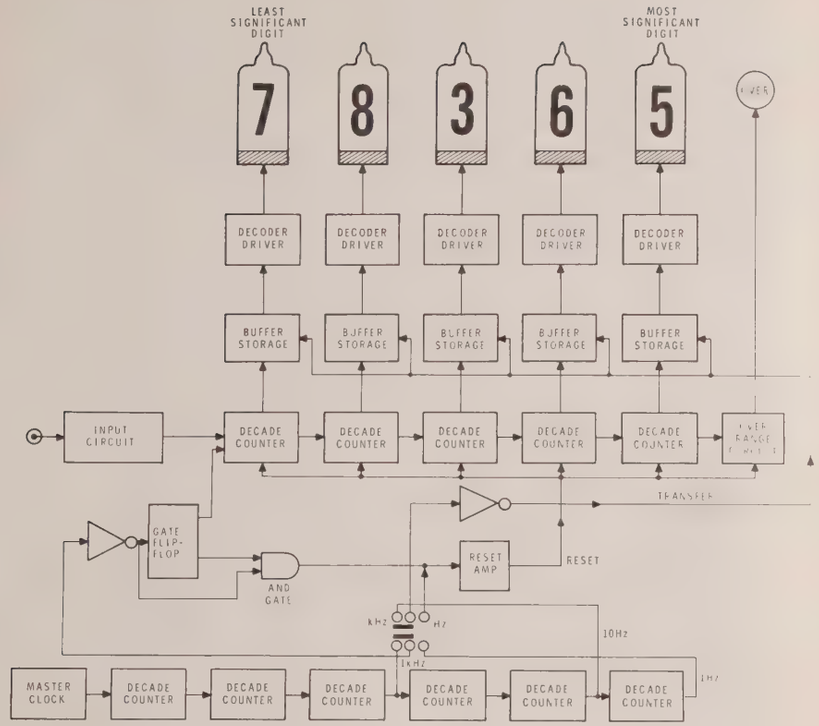


FIGURE 7



BLOCK DIAGRAM

OPERATION

Figure 8 gives a brief description of each control function.

COUNTING 5-DIGIT FREQUENCIES OR LESS

To count a frequency of five digits or less, push the RANGE switch to the Hz position and wait 4 seconds. Within 2 seconds a display will appear. However, this display is inaccurate as it was probably counted in less than one counting period. The second display, which will appear two seconds after the first, will be counted over a full counting period and will therefore be accurate.

COUNTING 6-DIGIT FREQUENCIES AND GREATER

To count a frequency of 11,381,367 Hz for example, push the RANGE switch to the kHz position. (The 4-second wait is not necessary as the frequency display is updated each 1/10 second in this range.) Record the display mentally or on paper; it will read 11,381 kHz. Push the RANGE switch to the Hz position and record this reading; it will read 81,367. (The OVER lamp will turn on in this example as the frequency will be 3 digits larger than can be displayed.) Putting the two readings together, the frequency is read as 11,381,367 Hz.

± 1 COUNT

The clock of a digital counter is not synchronized with the incoming signal. That is, the 1-second standard in the Counter is started randomly with respect to the input signal. This makes it necessary to wait for 4 seconds when the RANGE switch is in the Hz position and causes a ±1 count error as shown in Figure 9. If the clock starts as clock A, the counter will count 10 pulses in that second. However, if the clock starts as clock B, the counter will count 11 pulses in that second. Hence, digital counters have an inherent error of ±1 in the least significant digit. The range does not matter. The right-hand digit is always ±1 count.

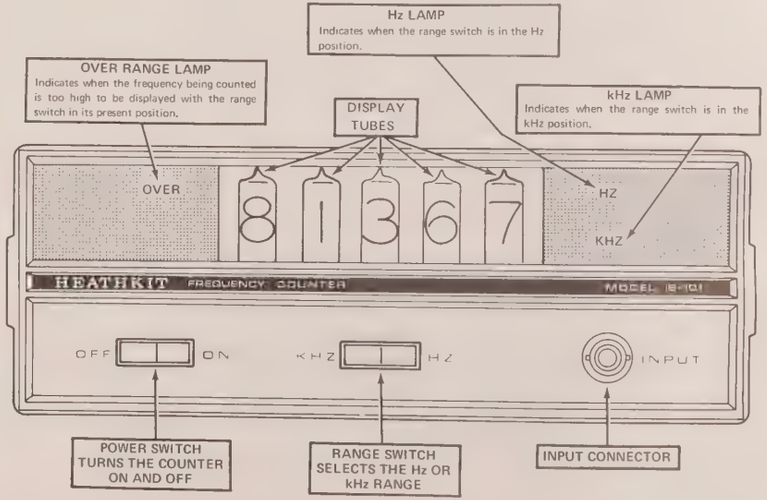

Hz LAMP
Indicates when the range switch is in the Hz position.
OVER RANGE LAMP
Indicates when the frequency being counted is too high to be displayed with the range switch in its present position.
DISPLAY TUBES
kHz LAMP
Indicates when the range switch is in the kHz position.
OVER
8 1 3 6 7
HZ
KHZ
HEATHKIT FREQUENCY COUNTER MODEL IB-101
OFF
ON
KHZ
HZ
INPUT
POWER SWITCH TURNS THE COUNTER ON AND OFF
RANGE SWITCH SELECTS THE Hz OR kHz RANGE
INPUT CONNECTOR

Figure 8

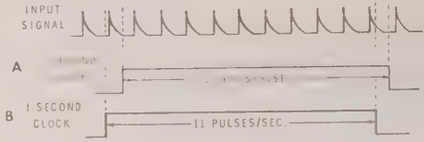


Figure 9

DC BLOCKING

If the input signal is superimposed on a dc level, connect an appropriate capacitor in series with the test cable. This will block the dc so the signal frequency can be counted.

IN CASE OF DIFFICULTY

Begin your search for any trouble that occurs after assembly by carefully following the steps listed in the Visual Tests section. After visual tests are completed, refer to the Troubleshooting Chart.

NOTE: Refer to the Circuit Board X-Ray View on Page 50 for the physical location of parts on the circuit board.

VISUAL TEST

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the kit builder.

2. About 90% of the kits that are returned to the Heath Company for repair do not function properly due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as described in the "Soldering" section of the "Kit Builders Guide."

3. Check to be sure that all transistors are in their proper locations. Make sure each lead is connected to the proper point.

4. Check that each of the IC pins are properly installed in their connectors, and not bent out or under the IC. Also be sure the IC's are installed in their correct positions.

5. Check the values of the parts. Be sure in each step that the proper part has been wired into the circuit, as shown in the Pictorial diagrams. It would be easy, for example, to install a 680 Ω (blue-gray-brown) resistor where a 6800 Ω (blue-gray-red) resistor should have been installed.

6. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring.

7. A review of the Circuit Description may also help you determine where the trouble is.

If the trouble is still not located after the visual tests are completed, and a voltmeter is available, check voltage readings against those shown on the Schematic Diagram (fold-out from Page 55). Read the "Precautions for Troubleshooting" before making any measurements. NOTE: All voltage readings were taken with a high impedance voltmeter. Voltages may vary as much as ±20%.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the "Service" section and Warranty of the "Kit Builders Guide" and to the "Factory Repair Service" information on Page 39 of this Manual.

PRECAUTIONS FOR TROUBLESHOOTING

1. Be cautious when testing IC and transistor circuits. Although they have almost unlimited life when used properly, they are much more vulnerable to damage from excessive voltage or current than tubes.

2. Be sure you do not short any terminals to ground when making voltage measurements. If the probe should slip, for example, and short out a bias or supply point, it is very likely to cause damage to one or more IC's, transistors, or diodes.

clock starts as clock B, the counter will count 11 pulses in that second. Hence, digital counters have an inherent error of ±1 in the least significant digit. The range does not matter. The right-hand digit is always ±1 count.

DC BLOCKING

If the input signal is superimposed on a dc level, connect an appropriate capacitor in series with the test cable. This will block the dc so the signal frequency can be counted.

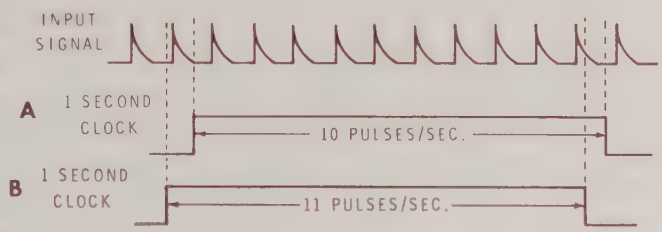


Figure 9

IN CASE OF DIFFICULTY

Begin your search for any trouble that occurs after assembly by carefully following the steps listed in the Visual Tests section. After visual tests are completed, refer to the Troubleshooting Chart.

NOTE: Refer to the Circuit Board X-Ray View on Page 50 for the physical location of parts on the circuit board.

VISUAL TEST

1. Recheck the wiring. Trace each lead in colored pencil on the Pictorial as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the kit builder.

2. About 90% of the kits that are returned to the Heath Company for repair do not function properly due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as described in the "Soldering" section of the "Kit Builders Guide."

3. Check to be sure that all transistors are in their proper locations. Make sure each lead is connected to the proper point.

4. Check that each of the IC pins are properly installed in their connectors, and not bent out or under the IC. Also be sure the IC's are installed in their correct positions.

5. Check the values of the parts. Be sure in each step that the proper part has been wired into the circuit, as shown in the Pictorial diagrams. It would be easy, for example, to install a 680 Ω (blue-gray-brown) resistor where a 6800 Ω (blue-gray-red) resistor should have been installed.

6. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring.

7. A review of the Circuit Description may also help you determine where the trouble is.

If the trouble is still not located after the visual tests are completed, and a voltmeter is available, check voltage readings against those shown on the Schematic Diagram (fold-out from Page 55). Read the "Precautions for Troubleshooting" before making any measurements. NOTE: All voltage readings were taken with a high impedance voltmeter. Voltages may vary as much as ±20%.

NOTE: In an extreme case where you are unable to resolve a difficulty, refer to the "Service" section and Warranty of the "Kit Builders Guide" and to the "Factory Repair Service" information on Page 39 of this Manual.

PRECAUTIONS FOR TROUBLESHOOTING

1. Be cautious when testing IC and transistor circuits. Although they have almost unlimited life when used properly, they are much more vulnerable to damage from excessive voltage or current than tubes.

2. Be sure you do not short any terminals to ground when making voltage measurements. If the probe should slip, for example, and short out a bias or supply point, it is very likely to cause damage to one or more IC's, transistors, or diodes.

Troubleshooting Chart

The chart lists the condition and the possible cause of the malfunction. If a particular part or parts are mentioned (transistor Q2 for example, or resistor R6) as a possible cause, check these parts to see if they are incorrectly installed or wired incorrectly. Also check to see if an improper part was installed at that location. It is also possible, on rare occasions, for a part to be faulty.

NOTE: Many integrated circuits have identical devices used in the Counter. A faulty IC can be discovered by interchanging it with a good one.

CONDITION	POSSIBLE CAUSE
One readout does not reset to zero with the input shorted.	1. Check associated decade counter, buffer storage, and decoder IC's.
Readouts will not reset to zero in the Hz or kHz range.	1. IC24. 2. Transistor Q2. 3. IC1, 2, or 3. 4. IC25. 5. Crystal Y1.
Unit functions normal in kHz range but not in Hz range.	1. IC6.
Display tubes will not light.	1. +170-volt supply. 2. Diode D3. 3. IC's 7, 8, 9, 10, or 11.
One or more display tubes will not light.	1. Diode D3.
One display tube does not indicate correct numeral from known frequency source.	1. Check associated decade counter, buffer storage, and decoder driver IC's.
Unit resets to zero but will not count.	1. Check position of the range (Hz-kHz) switch. 2. Check amplitude of input signal. 3. Transistor Q1. 4. IC24. 5. IC21. 6. DC on input signal.
Overrange lamp does not function or is on continuously.	1. Transistor Q3. 2. IC26. 3. Transistor Q4.
Counting sequence is displayed during gating.	1. Memory transfer line. 2. IC24.
Decimal point does not light.	1. Resistor R20. 2. Interchange tube V1 with another display tube.
Hz-kHz lamps. One or both does not function properly.	1. Switch S102. 2. Resistor R21. 3. Hz and/or kHz lamp.

FACTORY REPAIR SERVICE

You can return your completed kit to the Heath Company Service Department to have it repaired for a minimum service fee. (Kits that have been modified will not be accepted for repair.) If you wish, you can deliver your kit to a nearby Heath Authorized Service Center. These centers are listed in your Heathkit catalog.

To be eligible for replacement parts under the terms of the warranty, equipment returned for factory repair service, or delivered to a Heath Authorized Service Center, must be accompanied by the invoice or the sales slip, or a copy of either. If you send the original invoice or sales slip, it will be returned to you.

If it is not convenient to deliver your kit to a Heath Authorized Service Center, please ship it to the factory at Benton Harbor, Michigan and follow the following shipping instructions:

Prepare a letter in duplicate, containing the following information:

- Your name and return address.
- Date of purchase.
- A brief description of the difficulty.
- The invoice or sales slip, or a copy of either.
- Your authorization to ship the repaired unit back to you C.O.D. for the service and shipping charges, plus the cost of parts not covered by the warranty.

Attach the envelope containing one copy of this letter directly to the unit before packaging, so that we do not overlook this important information. Send the second copy of the letter by separate mail to Heath Company, Attention: Service Department, Benton Harbor, Michigan.

Check the equipment to see that all parts and screws are in place. (Do not include wooden cabinets when shipping receivers, tuners, amplifiers, or TV sets, as these are easily damaged in shipment.) Then, wrap the equipment in heavy paper. Place the equipment in a strong carton, and put at least THREE INCHES of resilient packing material (shredded paper, excelsior, etc.) on all sides, between the equipment and the carton. Seal the carton with gummed paper tape, and tie it with a strong cord. Ship it by prepaid express, United Parcel Service, or insured parcel post to:

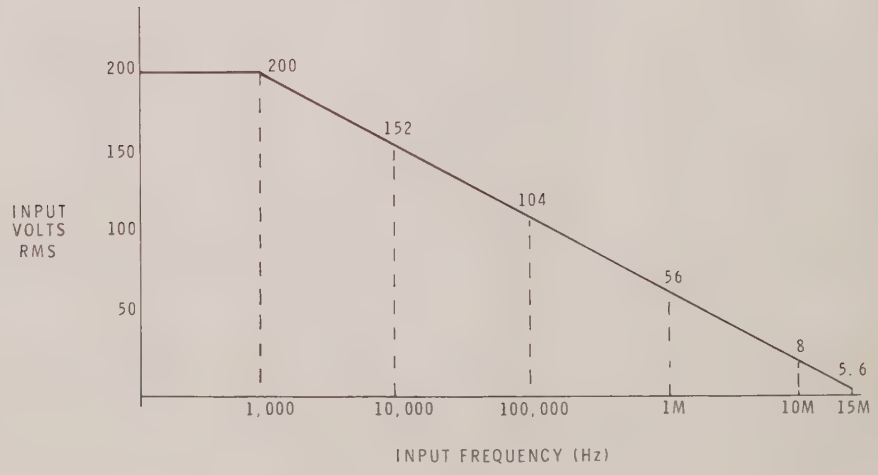
Heath Company
Service Department
Benton Harbor, Michigan 49022

SPECIFICATIONS

Frequency Range	1 Hz to >15 MHz.
Accuracy	±1 count ± time base stability.
Gate Times	1 millisecond or 1 second; with automatic reset.

INPUT CHARACTERISTICS

Sensitivity	1 Hz to 1 MHz; <100 millivolt rms. 1 MHz to 15 MHz; <250 millivolt rms after 30 minutes operation.
Trigger Level	Automatic.
Impedance	1 MΩ shunted by <20 pF.
Maximum Input	AC only, 200 volts rms; (dc coupled) 1 Hz to 1 kHz. (Derate 48 volts per frequency decade.)



TIME BASE

Frequency	1 MHz, crystal controlled.
Aging Rate	<1 PPM/Month after 30 days operation.
Ambient Temperature Stability	<±2 parts in 10^7/degree C. 20 degrees C to 35 degrees C after 30 minutes warmup.
	±.002 percent from 0 degrees C to 40 degrees C.

GENERAL

Readout	5 digit plus overrange.
Ambient Temperature Range	Storage: -55 degrees C to 80 degrees C.
	Operating: 0 degrees to 40 degrees C.
Power Requirements	105-125 or 210-250 Vac, 50/60 Hz, 8 watts.
Cabinet Dimensions	8-1/4" wide x 3-3/8" high x 9" deep. (Dimensions do not include handle.)
Net Weight	4-1/2 lbs.

The Heath Company reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

CIRCUIT DESCRIPTION

Refer to the Block Diagram (fold-out from Page 36) and Schematic Diagram (fold-out from Page 55) while you read this "Circuit Description."

GENERAL

The input amplifier and Schmitt trigger circuits accept and shape the input signal into a square-wave signal. Decade counters change these sequential input pulses into a binary-coded 8-4-2-1 output and recycle on every tenth input pulse. The four-bits of binary-coded information are then connected to the buffer/storage units which accept and store the count information on command of the transfer signal. The decoder-drivers translate the binary-coded information from the buffer/storage units into decimal form and drive the proper display tube cathodes. Timing signals for gating, transfer, and reset are generated in the clock and divider chain.

INPUT AMPLIFIER

The input amplifier consists of a dual-gate MOSFET. This particular type of device is used because it has a high impedance input which prevents loading of the circuits under test. It is also capable of handling a wide range of input voltages and waveshapes. Internal zener diodes protect this transistor against overload.

SCHMITT TRIGGER

Inverters E and F form a Schmitt trigger circuit. This circuit shapes the input signal so it is suitable for driving the logic circuits that follow. A low frequency input signal is taken from the drain of FET Q1 and attenuated by resistor R5 before reaching inverter F. At high frequencies, the impedance of capacitor C4 decreases, bypassing the signal around resistor R5. The impedance of coil L1 will increase as the input signal frequency increases. This prevents excessive attenuation of the high frequency input signals. The Schmitt trigger circuit is a regenerative bistable circuit which produces a square-wave output each time it is triggered and reset. This square-wave output may be interpreted as logic levels; logic 1 being the negative portion and logic 0 being the positive portion of the square wave as shown in Figure 10. Note that the logic 1 level is negative (low) with respect to the logic 0 level (high). This is called negative logic. Negative logic will be used throughout this "Circuit Description."

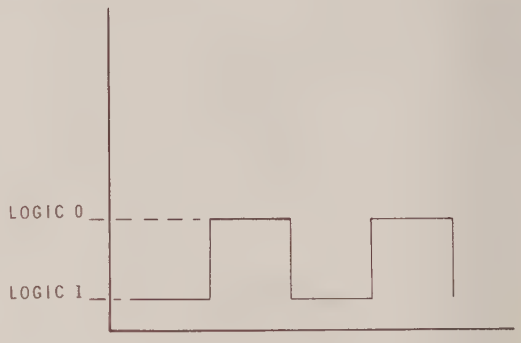


Figure 10

The Input Sensitivity control, R7 adjusts the threshold of the Schmitt trigger circuit. The voltage divider, formed by resistors R4, R5, R6, coil L1, and control R7 is adjusted so the voltage at the input of inverter F is just below its turn-on point. This insures that very small input signals can be measured with the Counter.

DECADE COUNTERS

The decade counters change the sequential input pulses from the Schmitt trigger into a binary-coded 8-4-2-1 output. The first decade counter consists of four J-K flip-flops and two NAND gates connected in such a way as to divide-by-ten as well as furnish the required 8-4-2-1 output.

Each of the J-K flip-flops have two complementary outputs Q and $\overline{Q}$ (not Q) which are always at opposite levels. When Q is logic 1, $\overline{Q}$ is logic 0; when Q is logic 0, $\overline{Q}$ is logic 1.

A flip-flop is said to be in its logic 1 state whenever the Q output is logic 1. It is in its logic 0 state whenever the Q output is logic 0.

The Cd (direct clear) input clears or presets the flip-flops to the logic 1 (negative logic) state regardless of any input applied. When a logic 0 level is applied to Cd, the Q output is forced to a logic 1 and $\overline{Q}$ to a logic 0 level.

The logic levels applied to control inputs S and C determine the output levels of Q and $\overline{Q}$ only after an adequate clock (or toggle) pulse is applied to input T. Changes in input level to S and C alone will not produce a change in output levels. A clock pulse applied to input T must be a negative-going pulse (logic 0 to logic 1) with a fast fall time, such as the trailing edge of a square wave. Steady-state logic level and positive-going pulses (logic 1 to logic 0) will not cause the flip-flop to change states.

Figure 11 illustrates the symbol and truth table for a J-K flip-flop. The tn+1 column shows the state of the flip-flop coincident with the application of the clock pulse. The term Qn represents the output state of the flip-flop prior to the application of a clock pulse; while $\overline{Qn}$ represents the output state opposite that which existed prior to the application of the clock pulse.

Figure 11

Figure 12 shows the symbol and truth table for a two input NAND gate. A logic 0 (high) is produced at the output only when both inputs are logic 1 (low) at the same time.

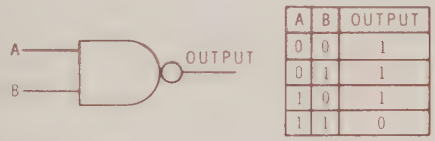


Figure 12

A NAND gate may also be used as an inverter if one input is held at logic 1. See Figure 13. Since the B input is grounded (logic 1), the output will always be at an opposite state from input A. Thus, the output signal is the inverse of the input signal.

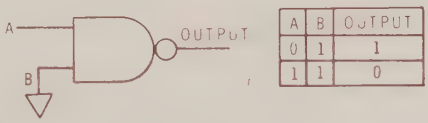


Figure 13

Figure 14 illustrates how four flip-flops and two NAND gates are connected to divide-by-ten, their waveform relationships, and a count sequence chart. Assume all four flip-flops to be in a reset state. In this condition, the Q output of each flip-flop will be low or logic 1 (negative logic). The binary-coded 8-4-2-1 output is 0000 (decimal 0).

As long as the S and C inputs are held at logic 0 (high) by the timing circuit, FF1 cannot change states. This timing signal, generated in the master oscillator circuit, allows the input signal to be counted for a predetermined length of time. Input signals are counted and accumulated for 1 ms in the kHz position of the Range switch and for 1 s in the Hz position.

The first negative-going input pulse at time t_1 sets FF1 to its 0 state. Output $\overline{Q}$ is now logic 1 and the 8-4-2-1 output is 0001 (decimal 1).

The second negative-going input pulse at time t_2 sets FF1 to its 1 state. As the Q output of FF1 goes negative, it sets FF2 to its 0 state. The $\overline{Q}$ output of FF2 is now logic 1 and the 8-4-2-1 output is 0010 (decimal 2). Since the Q output of FF4 is coupled to the C input to FF2, FF2 is enabled when FF4 is in its reset state (Q=logic 1). Only when FF4 is in its 0 state will FF2 be inhibited. The Q output of FF1 is also applied to the T input of FF4. Since FF4 is also inhibited (C input high) by gate C, FF4 cannot change states. Only when the $\overline{Q}$ outputs from FF2 and FF3 are logic 1 at the same time will FF4 be enabled.

The third input pulse at time t_3 will set FF1 to its 0 state. Both $\overline{Q}$ outputs from FF1 and FF2 are now logic 1 and the 8-4-2-1 output is 0011 (decimal 3). FF2 will not change states because the Q output of FF1 was a positive-going transistion (logic 1 to logic 0).

The fourth input pulse at time t_4 sets FF1 to its 0 state. The Q output of FF1 sets FF2 to its 0 state. The negative-going pulse from the Q output of FF2 sets FF3 to its 0 state. The $\overline{Q}$ output of FF3 is now logic 1 and the 8-4-2-1 output is 0100 (decimal 4). Since $\overline{Q}$ of FF2 is logic 0 and Q of FF3 is logic 1, the C input to FF4 is still inhibited by the NOR gates.

The fifth input pulse at t_5 sets FF1 to its 1 state. The $\overline{Q}$ outputs of FF1 and FF3 are logic 1 and the 8-4-2-1 output is 0101 (decimal 5).

The sixth input pulse at t_6 sets FF1 to its 1 state. The $\overline{Q}$ output of FF1 is now logic 0. The Q output of FF1 sets FF2 to its 0 state. The $\overline{Q}$ output of FF2 is now logic 1 and the 8-4-2-1 output is 0110 (decimal 6). Now that the $\overline{Q}$ outputs of FF2 and FF3 are both logic 1, FF4 is enabled, but will not change states until the Q output of FF1 produces a negative-going pulse.

The seventh input pulse at t_7 sets FF1 to its 0 state. The $\overline{Q}$ outputs from FF1, FF2, and FF3 are all logic 1 and the 8-4-2-1 output is 0111 (decimal 7).

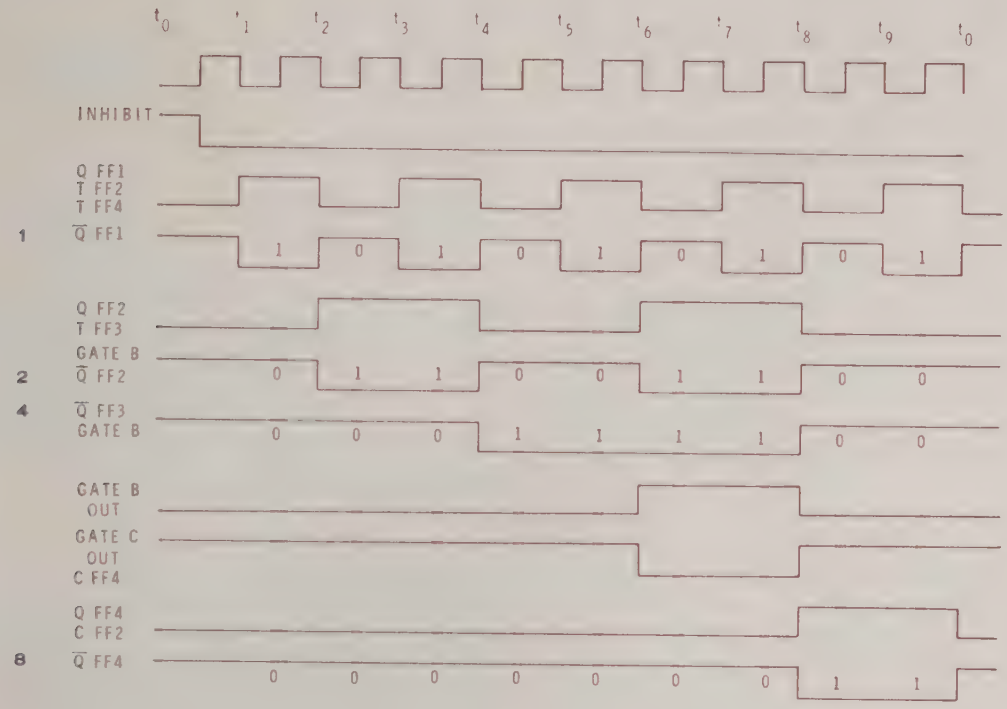
The eighth input pulse at t_8 sets FF1 to its 1 state. The Q output of FF1 sets FF2 to its 1 state and FF4 to its 0 state. The $\overline{Q}$ output of FF2 sets FF3 to its 1 state. The $\overline{Q}$ output of FF4 is now logic 1 and the 8-4-2-1 output is 1000 (decimal 8).

The ninth input pulse at t_9 sets FF1 to its 0 state. The $\overline{Q}$ output from FF1 and FF4 are both logic 1 and the 8-4-2-1 output is 1001 (decimal 9).

The tenth input pulse at t_{10} sets FF1 to its 1 state. Since the C input of FF2 is now inhibited by the Q output of FF4 it cannot change states. The C input to FF4 is also inhibited by the NOR gates. This inhibit level prevents setting FF4 to its 0 state, but does not inhibit setting it to its 1 state (reset). Thus, the $\overline{Q}$ output of FF1 sets FF4 to its 1 state. The $\overline{Q}$ output of FF4 supplies a carry pulse to the next decade counter. The $\overline{Q}$ outputs from all the flip-flops are now logic 0 and the 8-4-2-1 output is 0000.

Each of the remaining DCU's is contained in an individual integrated circuit. Operation of these decade counters is similar to that of the input DCU with the exception of the input trigger signal. Instead of being triggered by a negative-going signal, these DCU's are triggered by a positive-going signal. The 8-4-2-1 output and carry signals are coupled to the buffer/storage units and the next decade counter, respectively.

This decade counter will continue to count the input signal until a timing signal is applied to the S and C inputs of FF1 to inhibit the counter. A reset signal is also applied to the Cd inputs resetting each flip-flop to its 1 state.



STATE	1 Q FF1	2 Q FF2	4 Q FF3	8 Q FF4
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1
10/0	0	0	0	0

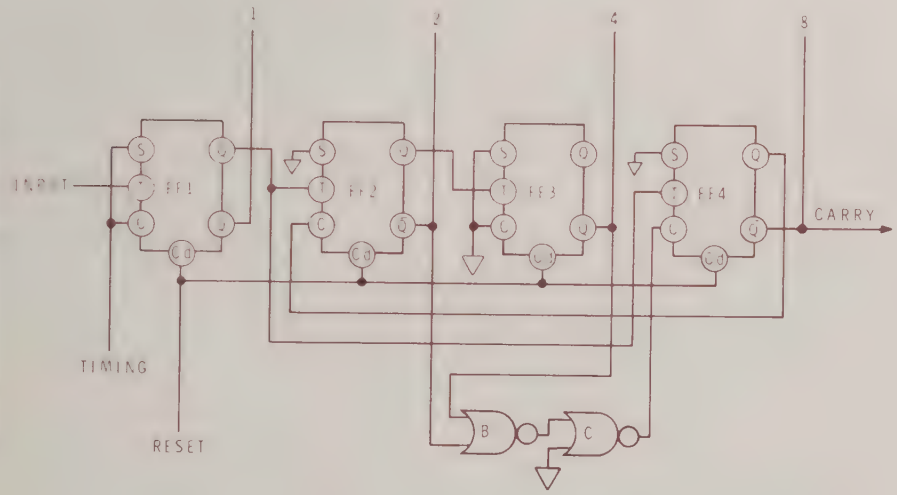


Figure 14

BUFFER/STORAGE UNITS

The buffer/storage units accept and store the binary-coded 8-4-2-1 outputs from the DCU's. Each time a transfer pulse is applied, the buffer/storage stages accept a new count from the DCU's and holds this count until the next transfer pulse. The transfer pulse originates in the clock circuit and after appropriate shaping and gating is applied to each buffer/storage unit.

Figure 15 illustrates a simplified block diagram of a buffer/storage unit. Only during the time a transfer signal is present at the transfer input are the flip-flops enabled. At this time the flip-flops will accept and store the 8-4-2-1 input. The 8-4-2-1 output of the buffer/storage units are applied to the decoder-drivers.

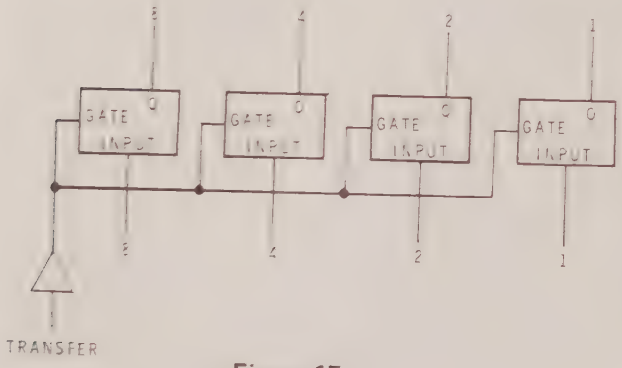


Figure 15

DECODER-DRIVERS

A matrix decodes the 8-4-2-1 input into decimal form. This decimal information then drives the appropriate cathodes of the display tubes. The numerals in the display tubes glow when the cathodes are grounded.

OVERRANGE

Inverter transistor Q3, integrated circuit IC26, and driver transistor Q4 form the overrange circuit. Flip-flops FFA and FFB of IC26 are connected as a latching circuit that turns on the "OVER" lamp any time a carry is produced by decade counter IC20.

Assume both flip-flops to be reset. The Q output of FFA places a logic 1 back to the S input of FFA. Since the C input to FFA is grounded, it is also at a logic 1 level. With a logic 1 at the S and C inputs, FFA will change states when a negative-going trigger signal is applied to the T input.

The S and C inputs of FFB, which are coupled to the Q and $\overline{Q}$ outputs of FFA, respectively, will follow the logic levels present at the Q and $\overline{Q}$ outputs of FFA. When FFA is reset (Q = logic 1), as is the case when the most significant DCU does not produce a carry pulse, the S input to FFB is logic 1 and the C input is logic 0. Under these conditions, a toggle signal applied to the T input will cause FFB to change to, or remain in, its 1 state. Since the $\overline{Q}$ output of FFB is then logic 0 (high), transistor Q4 is turned on; thus, shunting the Overrange lamp, turning it off.

A positive-going carry signal, produced by the most significant DCU, is inverted by transistor Q3. The carry signal is now negative-going and serves as a toggle signal to FFA, setting it to its 0 state. Output Q of FFA is fed back to the S input holding it at logic 0. A logic 0 at the S input and a logic 1 at the C input inhibits FFA from changing from its 0 state when additional toggle signals are applied to the T input. FFA is thus latched in its 0 state and can only be reset by applying a reset pulse to the Cd input.

With FFA in its 0 state, the S input of FFB is logic 0 and the C input is logic 1. These inputs will cause FFB to change to and remain in its 0 state when the next transfer pulse is applied to the T Input. Output $\overline{Q}$ of FFB then goes to logic 1 (low), turning off transistor Q4. This removes the shunt from the Overrange lamp, allowing it to turn on.

The next reset pulse will reset FFA to its 1 state. If a carry signal is again produced by the most significant DCU, FFA will set to its 0 state. FFB, however, will not change states and the Overrange lamp will remain lit. If a carry pulse is not generated, FFA will remain in its 1 state. The S input of FFB will now be logic 1 and the C input will be logic 1. The next transfer pulse will cause FFB to reset to its 1 state. Output $\overline{Q}$ of FFB, which is now logic 0, turns on transistor Q4 shunting the Overrange lamp, turning it off.

CLOCK

Gates A and D of IC25 are connected in a cross-coupled multivibrator configuration. Basically, a free-running oscillator, the output frequency is controlled by the crystal. Resistors R9 and R11 provide the bias for both gates as well as being part of the oscillator time constants. Trimmer capacitor C7 is adjusted so the oscillator frequency is exactly 1 MHz. The square-wave output drives the following DCU's.

The Divider chain consists of six cascaded DCU's. Since the binary-coded 8-4-2-1 outputs are not used, only the carry output is shown.

Three output signals, 1 kHz from IC3, 10 Hz from IC5, and 1 Hz from IC6, are used for timing purposes. A 10 kHz output from IC2 is coupled to the test point for use during calibration to adjust the input sensitivity of the Counter.

GATE

The Hz position of the range switch couples a 1 second (1 Hz) signal from the clock and divider chain to inverter B. Inverter B changes the clock signal into a negative-going pulse suitable for toggling FFB of IC22. FFB will now change states at a 1 Hz rate or once every second. The $\bar{Q}$ output or gate signal is used to both enable and inhibit input flip-flop IC21. During the one second interval when the input flip-flop is enabled, the input signal is counted. The one second interval the input flip-flop is inhibited, the accumulated count is transferred, stored, displayed, and reset. Thus, the Hz position of the range switch requires two seconds to complete its cycle.

The kHz position of the range switch couples a 1 millisecond (1 kHz) signal from the clock and divider chain to inverter B. FFB of IC22 will change states at a 1 kHz rate or once every 1 millisecond. The input signal is counted for 1 millisecond periods in the kHz position of the range switch.

TRANSFER

Figure 16 shows how two inverters can be connected to form a NAND gate. The truth table for this particular NAND gate, often called the "wired NAND" gate, is the same as the NAND gate previously explained.

Inverters C and D form a NAND gate that produces an output pulse at the same time flip-flop IC21 is inhibited. This output pulse is differentiated by capacitor C12 and resistor R16 before it is applied to inverter A in the Hz position of the Range switch. The output of this inverter forms the transfer pulse that transfers and stores the count, present in the DCU's, in the buffer/storage units. The kHz position of the range couples a .1s (10 Hz) signal from the clock and divider chain to inverter A. Thus, in the kHz position of the Range switch, the transfer pulse is generated in the clock divider chain circuit.

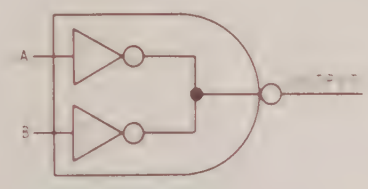


Figure 16

The output of the NAND gate (inverters C and D) is also applied to the Cd input of FFB of IC22 for synchronization.

RESET

The NAND gate output is also differentiated by C14 and R17 and then delayed slightly by R18 and C15 before it reaches transistor Q2. The reset pulse generated by Q2 resets all the DCU's after the 8-4-2-1 has been transferred to the buffer/storage units and before the input flip-flop (IC21) is gated on by the gate signal.

POWER SUPPLY

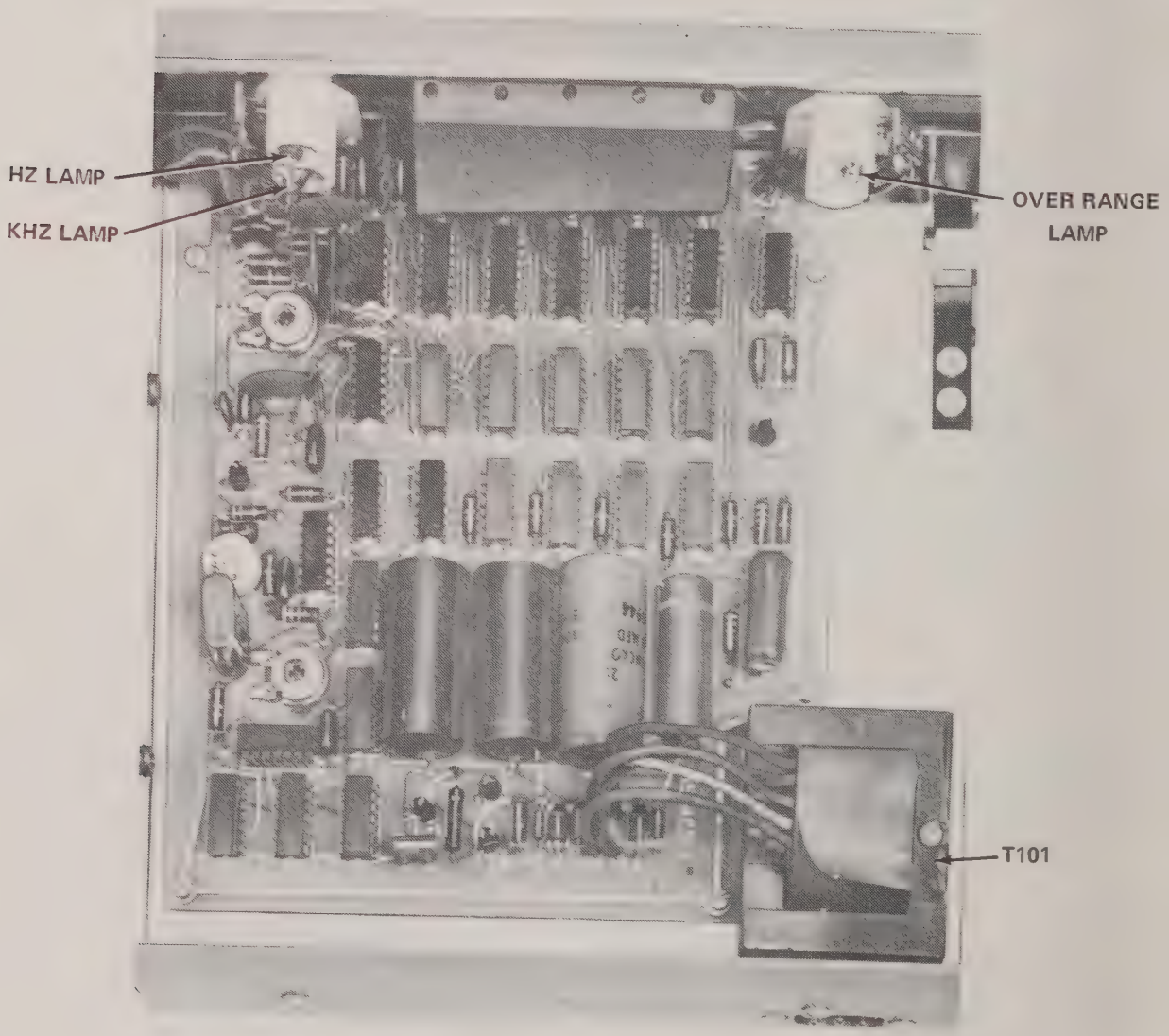
The dual-primary transformer T101 can be wired to operate from either 120 Vac or 240 Vac. Two secondary output windings furnish the ac voltage for the +3.5-volt and the +170-volt power supplies.

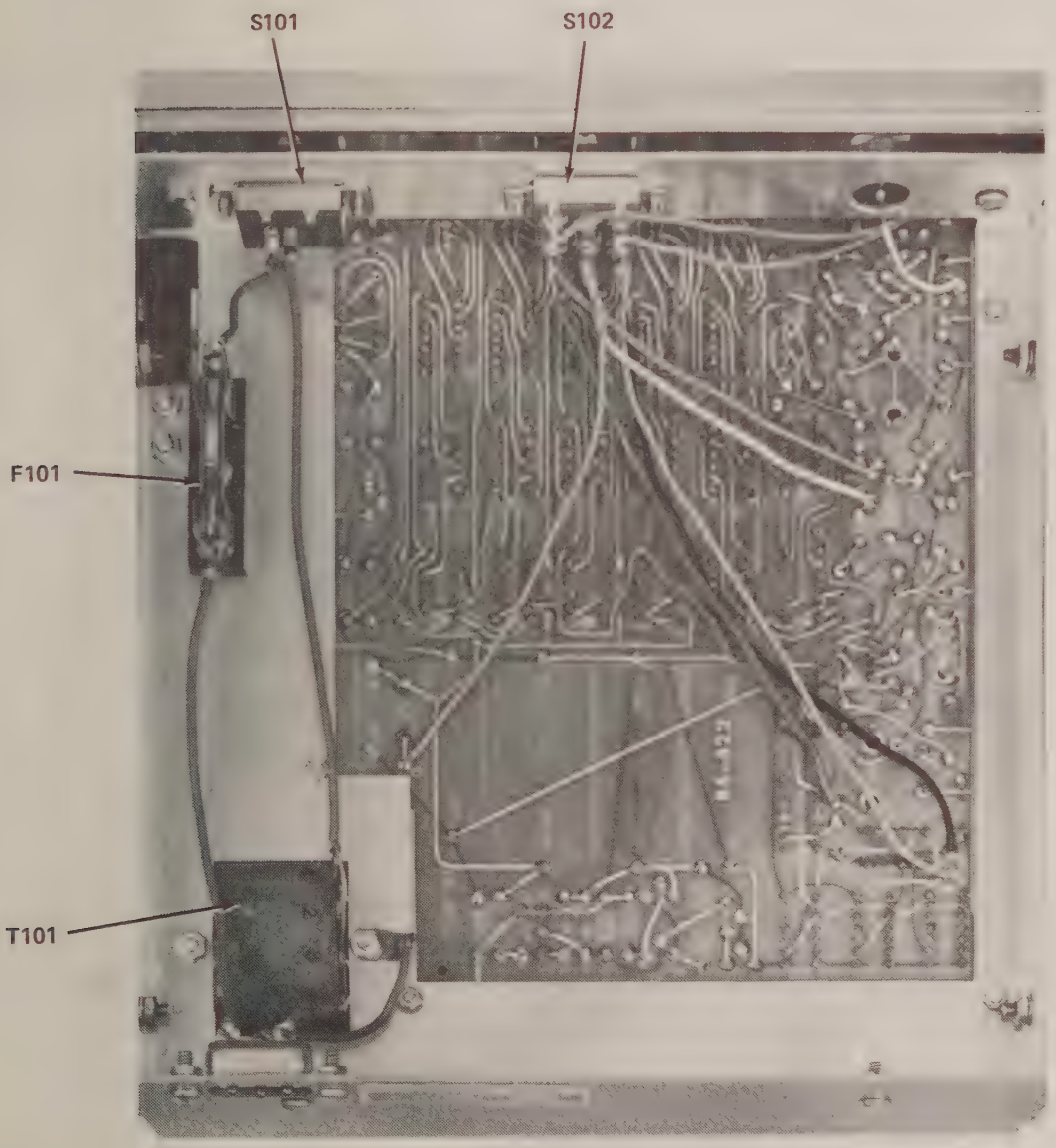
Diodes D1 and D2 form a full-wave rectifier for the 3.5-volt regulator. Transistors Q5 and Q6 form a constant current source to maintain a constant current through zener diode ZD2 over a wide voltage range. The bias of Q7 is held constant by ZD2. Since the bias of Q8 is held constant by Q7, the output voltage will remain constant. An increase in the dc voltage into the regulator will cause the emitter voltages of Q8 and Q7 to try to increase. Increasing the emitter voltage will decrease the forward bias, maintaining the output voltage at +3.5 volts. Capacitor C16 and C17 provide filtering for the 3.5-volt supply.

Diode D3 forms a half-wave rectifier for the +170-volt power supply. Capacitor C18 provides filtering for the +170-volt supply.

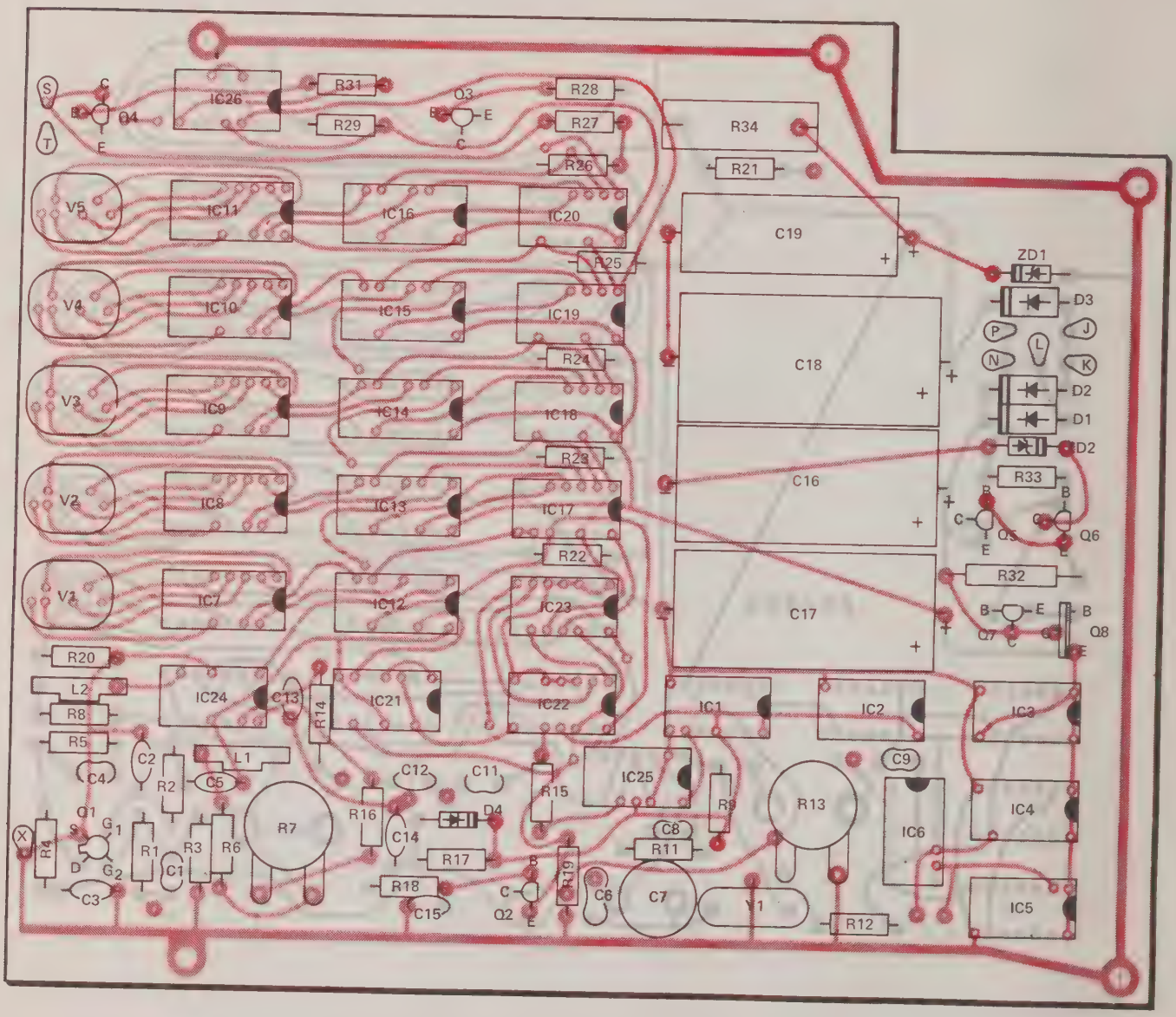
Resistor R34 provides current limiting for zener diode ZD1 which regulates the output at 36 volts. Capacitor C19 provides filtering.

CHASSIS PHOTOGRAPHS




S101
S102
F101
T101

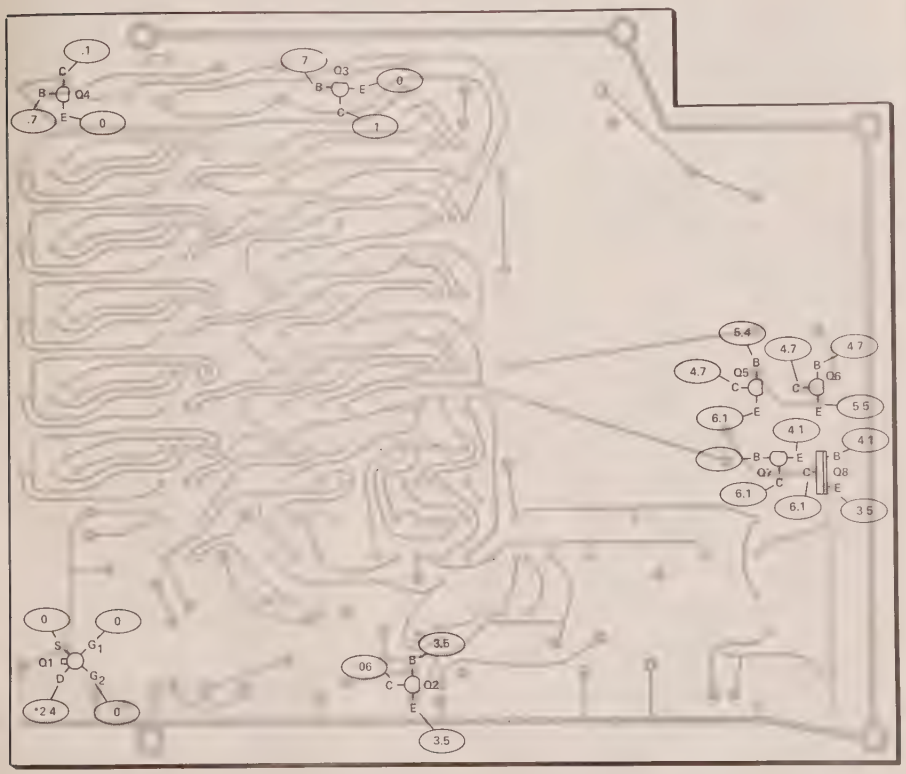
CIRCUIT BOARD X-RAY VIEW



VIEWED FROM SCREENED SIDE OF CIRCUIT BOARD

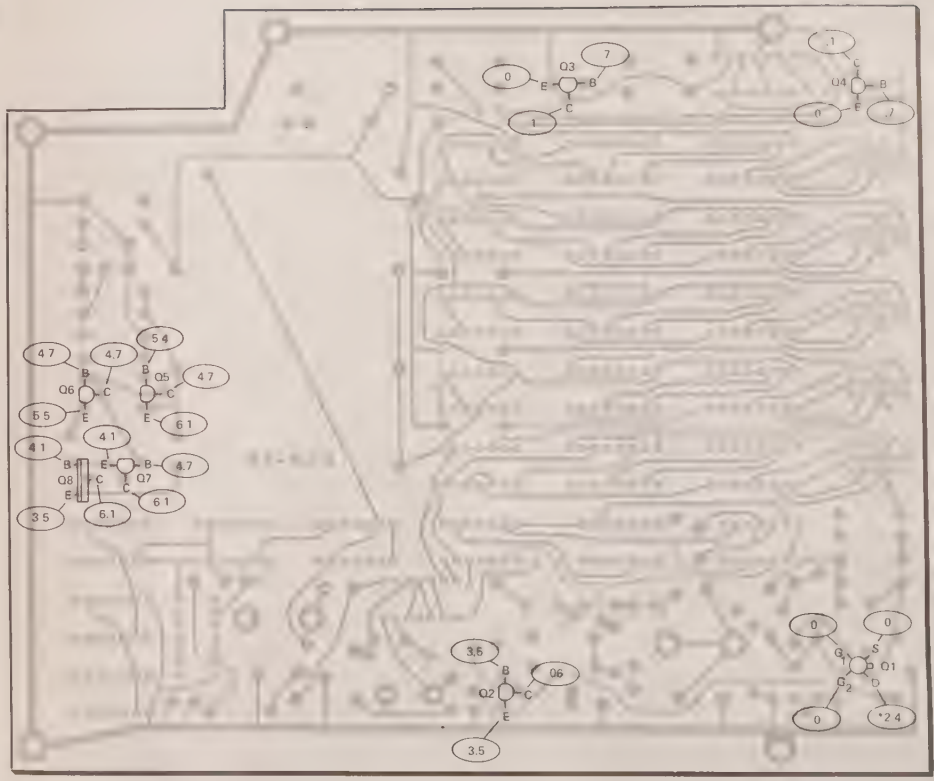
(Red is top foil, gray is bottom foil)

CIRCUIT BOARD VOLTAGE CHARTS



* Depends on setting of input sensitivity control.

VIEWED FROM TOP OF CIRCUIT BOARD



VIEWED FROM BOTTOM OF CIRCUIT BOARD

*Depends on setting of input sensitivity control.

REPLACEMENT PARTS PRICE LIST

The following prices apply only on purchases from the Heath Company where shipment is to a U.S.A. destination. Add 10% (minimum 25 cents) to the price when ordering from an authorized Service Center or Heathkit Electronic Center to cover local sales tax, postage and handling. Outside the U.S.A. parts and service are available from your local Heathkit source and will reflect additional transportation, taxes, duties and rates of exchange.

To order parts, use the Parts Order Form furnished with this kit. If Parts Order Form is not available, refer to Replacement Parts in the Kit Builder Guide.

PART No.	PRICE Each	DESCRIPTION
RESISTORS		
1/2-Watt, 5%		
1-151	.10	330 Ω
1-157	.10	470 Ω
1-52	.10	680 Ω
1-81	.10	1500 Ω
1-150	.10	3000 Ω
1-122	.10	3300 Ω
1-43	.10	4700 Ω
1-51	.10	6800 Ω
1-105	.10	10 kΩ
1-115	.10	47 kΩ
1-50	.10	68 kΩ
1-104	.10	100 kΩ
1-101	.10	1 MΩ
Other Resistors-Control		
1-9	.10	1000 Ω, 1/2-watt, 10% resistor
2-219	.40	21.62 Ω, 1% resistor
3-2-5	.75	10 kΩ, 5-watt resistor
10-171	.40	500 Ω control
CAPACITORS		
Disc		
21-24	.10	800 pF
21-52	.10	.002 μF
21-47	.10	.01 μF
21-48	.15	.05 μF
Mica		
20-101	.15	47 pF
20-102	.15	100 pF
20-107	.40	680 pF
Electrolytic		
25-94	.75	10 μF
25-128	.75	100 μF
25-201	1.05	2000 μF
Other Capacitors		
31-36	.85	8-50 pF trimmer
21-41	.10	14 pF ceramic
TUBE-TRANSISTORS-INTEGRATED CIRCUITS		
411-264	7.15	B5859S display tube
417-118	.40	2N3393 transistor
417-201	.50	X29A829 transistor
417-173	.45	NPN transistor
417-240	2.40	40673 transistor
417-175	1.45	TA2911 transistor
443-8	2.25	MC724P integrated circuit
443-14	2.50	MC789P (selected) integrated circuit
443-28	5.00	CμL995879 integrated circuit
443-29	5.00	CμL995979 integrated circuit
443-30	5.00	CμL996079 integrated circuit
443-31	2.50	MC726P (selected) integrated circuit
443-32	3.70	MC790P (selected) integrated circuit
DIODES-CRYSTAL-LAMP		
56-26	.25	Crystal diode, 1N191 (brown-white-brown)
56-55	1.00	36 V zener diode, VR-36A
56-59	.65	4.7 V zener diode, 1N750A
57-27	.50	Silicon diode, 1N2071
404-414	9.15	1 MHz crystal
412-49	.40	Neon lamp

SWITCHES-SOCKETS-ADAPTER-CONNECTORS

PART No.	PRICE Each	DESCRIPTION
60-40	.85	3PDT switch
60-45	.50	SPST switch
432-76	.30	AC power socket
434-201	1.10	Tube socket
432-27	.40	Plug adapter
432-59	1.65	BNC connector (with hardware)
432-144	.01	Integrated circuit (IC) connector

LINE CORD-WIRE-CABLE

89-30	1.25	3-wire line cord
340-11	.05/ft	Bare wire
344-50	.05/ft	Black wire
344-51	.05/ft	Brown wire
344-21	.05/ft	Large red wire
344-52	.05/ft	Small red wire
344-53	.05/ft	Orange wire
344-54	.05/ft	Yellow wire
344-55	.05/ft	Green wire
344-56	.05/ft	Blue wire
344-57	.05/ft	Violet wire
344-58	.05/ft	Gray wire
134-237	2.20	Cable assembly (with connector)

HARDWARE

#4 Hardware

250-3	.05	4-40 x 3/16" screw
250-52	.05	4-40 x 1/4" screw
252-15	.05	4-40 nut
254-9	.05	#4 lockwasher

#6 Hardware

250-89	.05	6-32 x 3/8" screw
250-434	.05	6-32 x 3/8" flat head screw
250-535	.25	6-32 x 1/4" screw
252-3	.05	6-32 nut
254-1	.05	#6 lockwasher
259-1	.05	#6 solder lug
255-103	.10	6-32 x 5/16" threaded spacer

Other Hardware

253-75	.05	3/8" flat washer

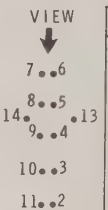
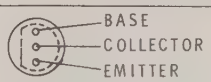
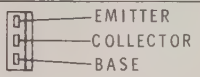
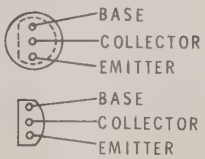
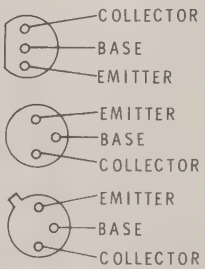
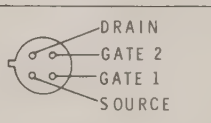
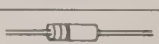
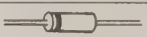
METAL PARTS

90-505-1	1.65	Cabinet shell
200-592	1.25	Chassis
100-1039	4.15	Front panel
203-747-1	.45	Rear panel
203-748	.50	Left panel
203-749	.50	Right panel
205-780	1.05	Cabinet trim plate
211-51	1.55	Handle
258-106	.20	Flat spring
266-194	.40	Handle detent
205-141	.10	Tool plate

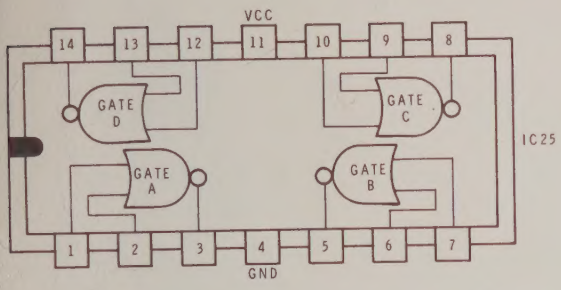
MISCELLANEOUS

40-581	.15	620 μH coil
54-260	5.00	Power transformer
73-34	.10	Rubber insulator
85-422-2	10.10	Circuit board
205-778	.10	1/8" x 1" metal strip
211-52	.90	Plastic handle-grip
214-124	.20	Lamp housing
260-16	.10	Alligator clip
261-29	.05	Plastic foot
262-13	.05	Pin
390-331	.30	Control label
75-156	.10	Light shield
390-357	.30	"Heathkit" label
421-33	.30	1/4-ampere, slow-blow fuse
422-1	.25	Fuseholder
431-38	.10	3-lug terminal strip
490-5	.10	Nut starter
331-6	.15	Solder
	2.00	Manual (See front cover for part number.)

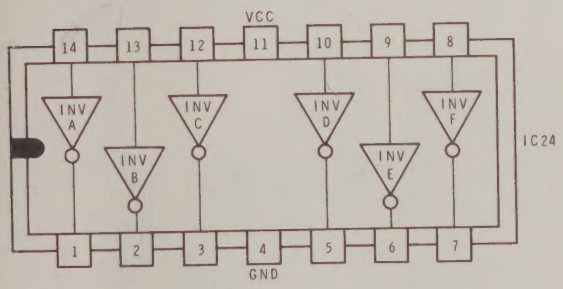
IDENTIFICATION CHART

COMPONENT	HEATH PART NUMBER	MAY BE REPAIRED WITH	BASE DIAGRAM (BOTTOM VIEW)
V1, V2, V3, V4, V5	411-264	NATIONAL ELECTRONICS NL905S OR BURROUGHS B-5859S	 PIN / CONNECTION: 1 NUMERAL 1; 2 NUMERAL 2; 3 NUMERAL 3; 4 NUMERAL 4; 5 NUMERAL 5; 6 NUMERAL 6; 7* ANODE; 8 NUMERAL 7; 9 NUMERAL 8; 10* ANODE; 11 NUMERAL 9; 12 NUMERAL 0; 13 RT. DEC. PT.; 14 LFT. DEC. PT. * CONNECTED INTERNALLY
Q2, Q5, Q6	417-201	X29A829	
Q8	417-175	TA2911	
Q3, Q7	417-118	2N3393	
Q4	417-173	2N2509	
Q1	417-240	RCA 40673	
D1, D2, D3	57-27	IN2071	
D4	56-26	IN191	
ZD1	56-55	VR-36, 36VOLT, 4mA ZENER	
ZD2	56-59	1N750A 4.7VOLT, 20mA ZENER	

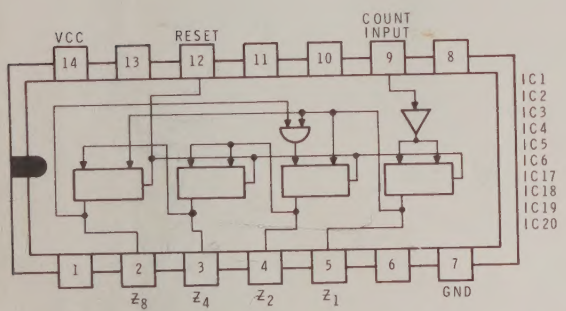
TOP VIEW



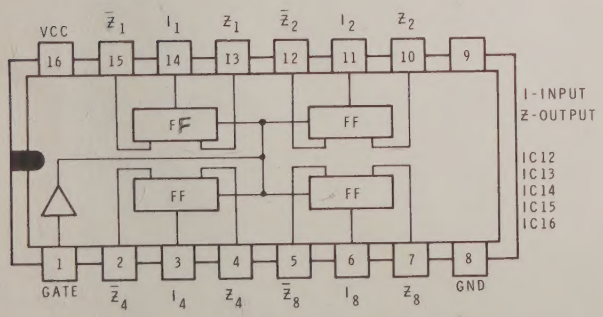
MC724P QUADRUPLE 2-INPUT
NAND/NOR GATE
#443-8



MC789P (Selected 15MHz)
HEX INVERTER
#443-14

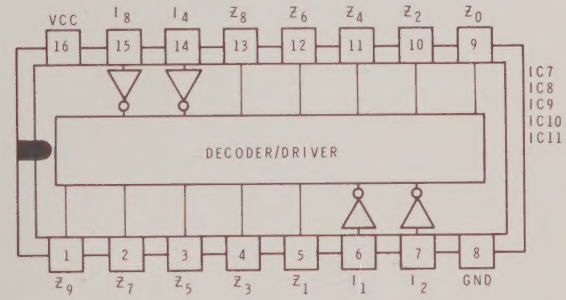


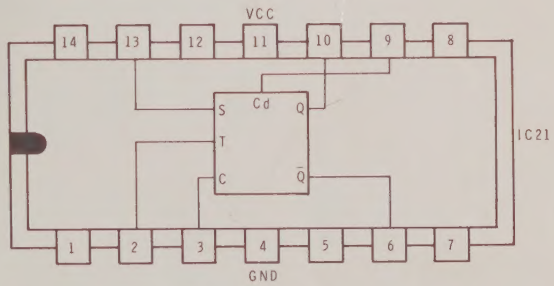
CμL995879 DECADE COUNTER
#443-28



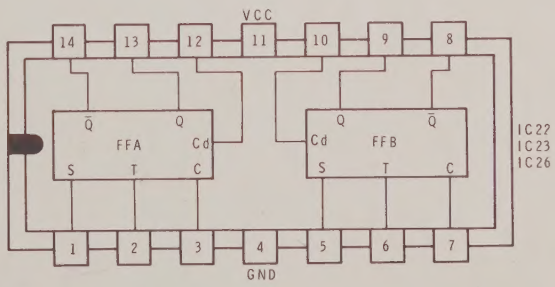
CμL995979 BUFFER-STORAGE
ELEMENT
#443-29

CμL996079 DECODER/DRIVER
#443-30



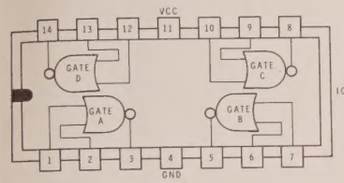


MC726P (Selected 15MHz) single
J-K FLIP-FLOP
#443-31

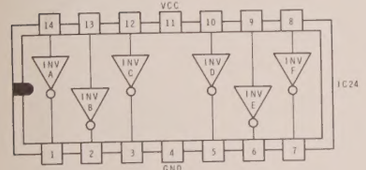


MC790P (Selected 8MHz) DUAL
J-K FLIP-FLOP
#443-32

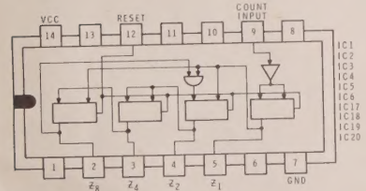
TOP VIEW



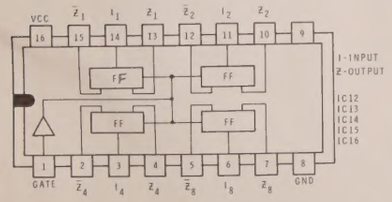
MC724P QUADRUPLE 2-INPUT
NAND/NOR GATE
#443-8



MC789P (Selected 15MHz)
HEX INVERTER
#443-14

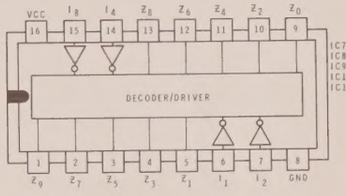


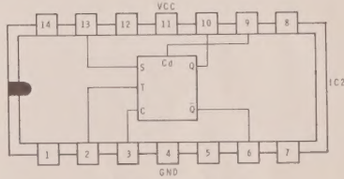
CuL995879 DECADE COUNTER
#443-28



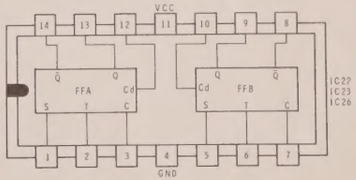
CuL995979 BUFFER-STORAGE
ELEMENT
#443-29

CuL996079 DECODER/DRIVER
#443-30

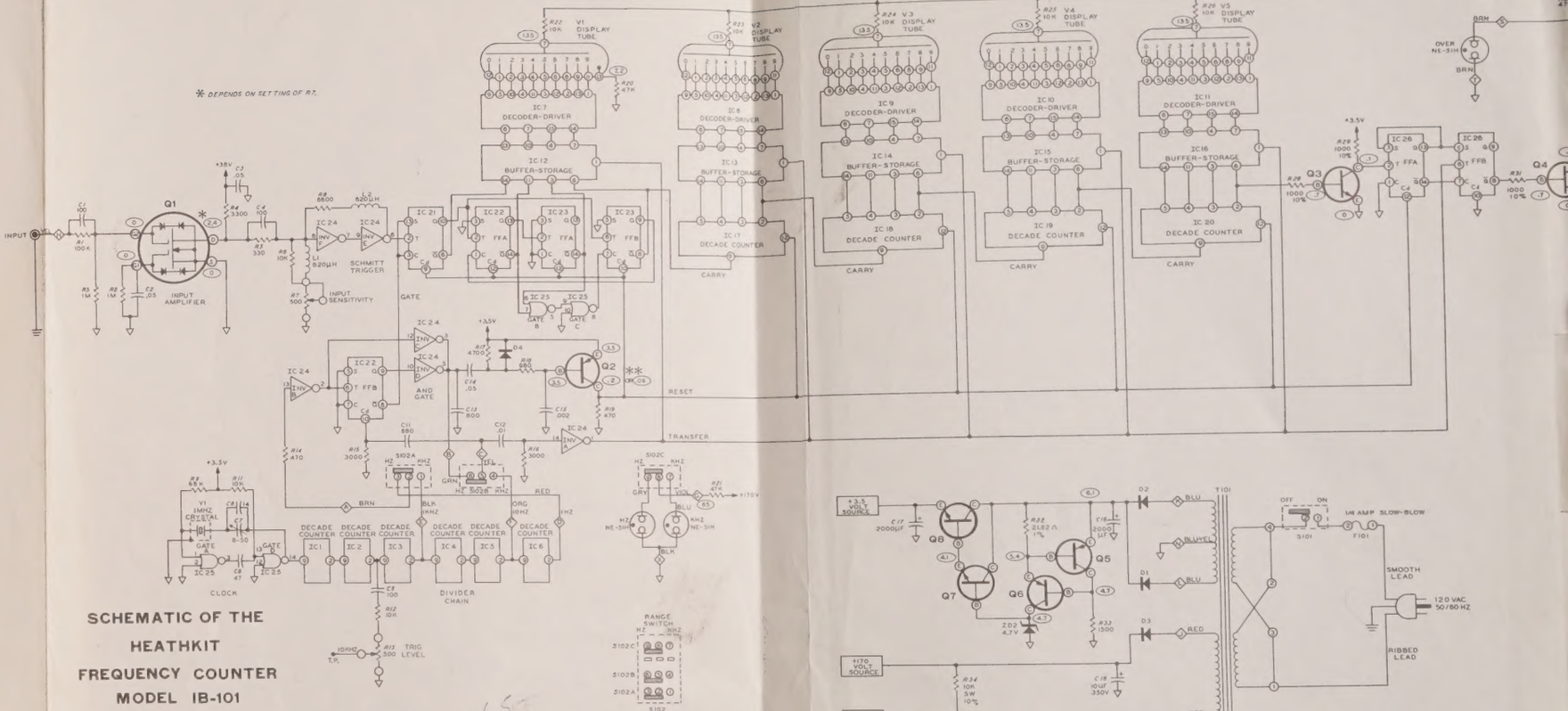




MC726P (Selected 15MHz) single
J-K FLIP-FLOP
#443-31



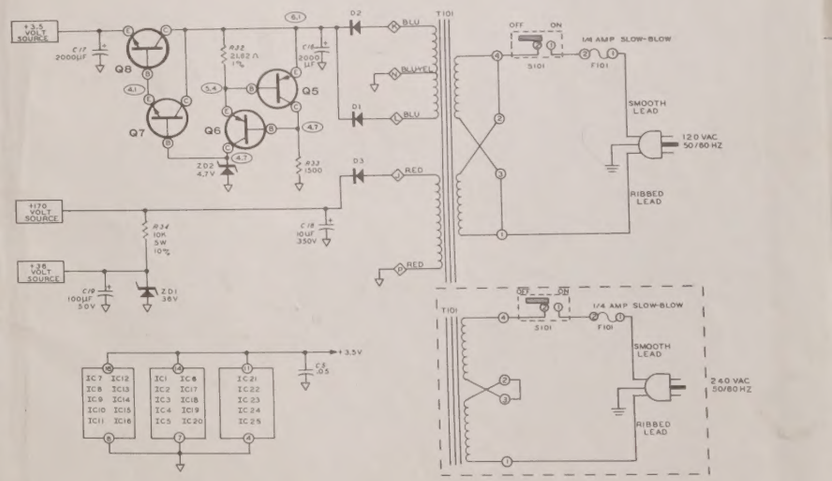
MC790P (Selected 8MHz) DUAL
J-K FLIP-FLOP
#443-32



SCHEMATIC OF THE HEATHKIT FREQUENCY COUNTER MODEL IB-101

NOTES:

1. COMPONENT NUMBERS ARE IN THE FOLLOWING GROUPS:
   1-99 PARTS MOUNTED ON THE CIRCUIT BOARD.
   100-199 PARTS MOUNTED ON THE CHASSIS.
2. ALL RESISTORS ARE 1/2 WATT UNLESS MARKED OTHERWISE. RESISTOR VALUES ARE IN OHMS (K=1000, M=1,000,000).
3. ALL RESISTORS ARE 5% UNLESS MARKED OTHERWISE.
4. ALL CAPACITOR VALUES LESS THAN 1 ARE IN µF. VALUES OF 1 AND ABOVE ARE IN pF UNLESS MARKED OTHERWISE.
5. REFER TO THE CHASSIS PHOTOGRAPHS AND CIRCUIT BOARD X-RAY VIEWS FOR THE PHYSICAL LOCATION OF PARTS.
6. ▽ THIS SYMBOL INDICATES CIRCUIT BOARD GROUND.
7. ⏚ THIS SYMBOL INDICATES CHASSIS GROUND.
8. ◇ THIS SYMBOL INDICATES A LETTERED CIRCUIT BOARD CONNECTION.
9. ⬭ THIS SYMBOL INDICATES A DC VOLTAGE TAKEN WITH A HIGH IMPEDANCE INPUT VOLTMETER FROM THE POINT INDICATED TO CHASSIS GROUND WITH NO INPUT SIGNAL TO THE COUNTER. VOLTAGES MAY VARY ±20%.
10. ** WITH THE RANGE SWITCH IN THE HZ POSITION, THE VOLTAGE IS .06 VOLTS. WITH THE RANGE SWITCH IN THE KHZ POSITION, THE VOLTAGE IS .2 VOLTS.



HEATH COMPANY

BENTON HARBOR, MICHIGAN

MP MASTER
MA23008

THE WORLD'S FINEST ELECTRONIC EQUIPMENT IN KIT FORM

LITHO IN U.S.A.